MEETING DATE: 1/12/09

AGENDA ITEM: Authorization to Issue a Request for Proposals for Design Services for the Improvement of the Braddock Sewer Pump Station

ATTACHMENTS

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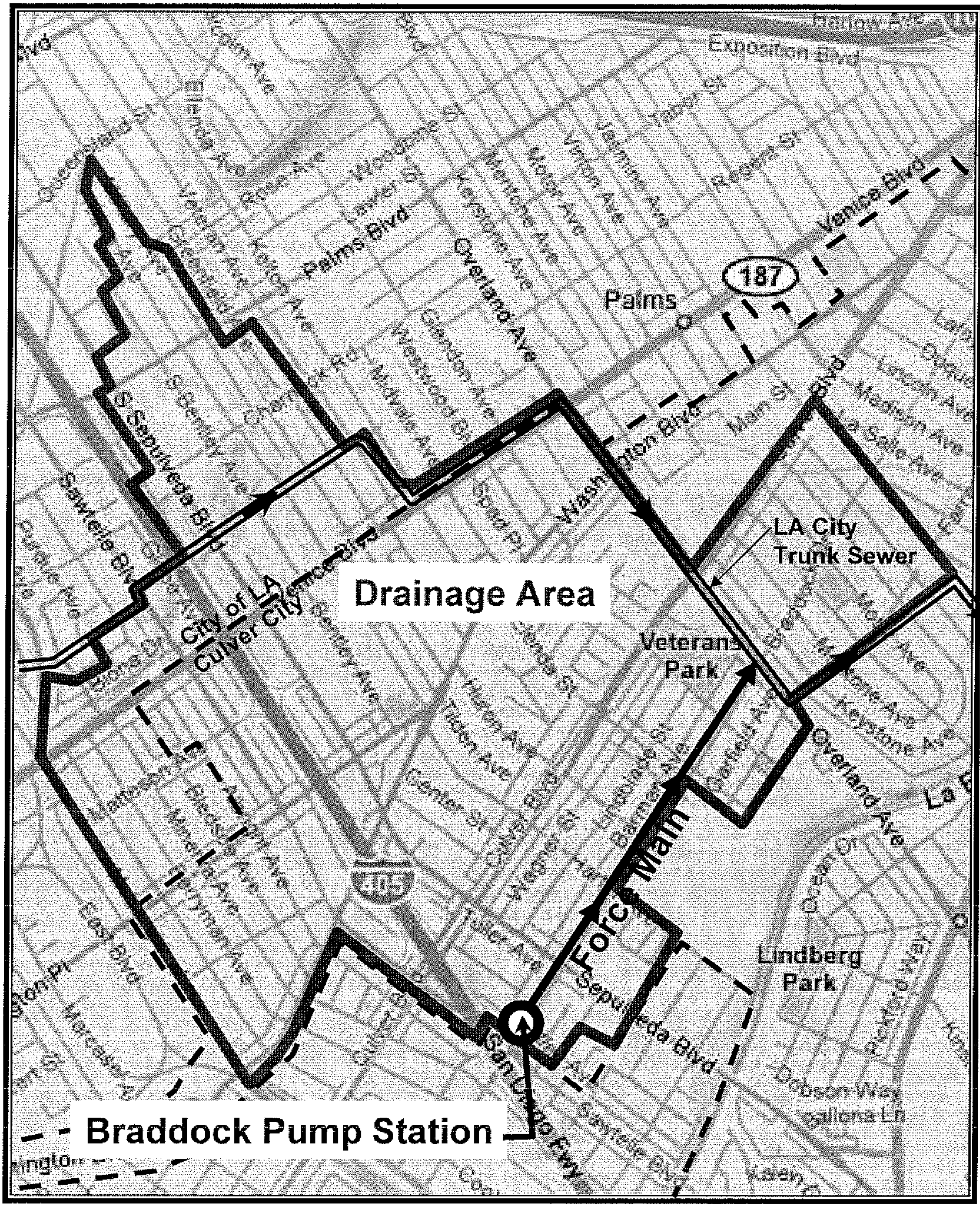

Braddock Sewer Pump Station and Force Main
Location and Drainage Area
ATTACHMENT 1

City of Culver City

PRELIMINARY DESIGN REPORT

FOR

Braddock Sewage Lift Station Improvements

Prepared for:

City of Culver City
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Environmental Program
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JN1182

DECEMBER, 2008

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ACKNOWLEDGEMENT

This Preliminary Design Report has been prepared by or under the direction of the following design professional, licensed by the State of California.

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I. PROJECT OVERVIEW

A. Project Description

The existing Braddock Sewage Lift Station is located on the northeast corner of the intersection of Braddock Drive and Sawtelle Boulevard in the City of Culver City. City records indicate that the station has existed at this location since prior to 1945.

The Station consists of a circular wet well, a rectangular dry well with three centrifugal pumps and a above ground block structure housing the control systems. The station presently collects the Culver City and City of Los Angles demands and pumps them through an 18" force main approximately 4640 ft to a LA Sanitation District Interceptor sewer that ultimately flows to the Hyperion Wastewater Treatment Plant.

The station has been improved and upgraded several times; however, operational problems plague the station. The facility has a non-standard pump/wet well configuration that does not conform to the Hydraulic Institute Standards (HIS). The HIS is a summary of standards that have been established by the pump manufacturers as the minimum installation configuration necessary to operate pumps safely and efficiently. The present station configuration causes an extreme buildup and collection of sewage solids and sludge that impacts pump operation and ultimately lowers the station's pumping capacity. The station's wet well floor is at elevation 15.0. The 18" sewer inlet is also at elevation 15.0. This configuration causes station fill/draw cycle poundings to occur both in the wet well and in the surrounding collection system.

The station's normal operating cycle has a pump off level approximately 3 ft above the wet well floor that rises an additional 2 feet for all three pumps to cycle on. Therefore, the sewer system is typically backed up to elevation 20 during the pump cycle operation and all sewers with inverts below elevation 18 would be submerged or back up at all times. This type of operation will collect sludge and sewage solids within the wet well and collection sewers below elevation 18, which reduces the station's pumping capacity.

The 12" suction lines leading from the wet well to the pumps are configured in a manner that reduces pump capacity and creates maintenance problems. The suction lines are located too close together in the wet well and with the build up of solids, the pumps starve one another when two or more operate together. Additionally, vortexes could form during multiple-pump operation at lower well levels causing cavitation in the pump volute, which would reduce pumping capacity and could damage the pumps.

B. Project Development and Phasing

In order, to eliminate the present operational problems with the build up of solids, reduced pump capacity and premature pump failures, the proposed station improvements will provide a new wet well constructed to elevation approximately 10 feet lower than the existing inlet sewer such that the fill/draw cycle could be contained in the wet well. The existing facility has several site restrictions that limit the potential improvements and area to construct a new wet well. Therefore, two alternatives were discussed and considered for the ultimate station improvements, including demolition of the existing dry well and wet well and construction of a new dry well and wet well 10 feet lower than the existing station. This cost of this alternative is estimated to be at least 50% higher than the other proposed option. Additionally, the new wet/dry wells would require an extra 2 or 3 months to construct and another 2 – 3 months of temporary bypass pumping adding cost and risk.

The second alternative consists of constructing a single, deeper rectangular wet well to house three submersible pumps. The wet well would be constructed adjacent to the existing dry well under the sidewalk and parking lane of Sawtelle Boulevard. The existing dry well would be modified and used as a valve vault for the three pumps. The existing dry well will require the removal of existing valves, supply piping and pumps for the installation of the new valves and piping system.

The existing wet well will be used during construction for temporary bypass pump operation, which would consist of two submersible pumps whose combined flow rate will provide the station's flow capacity. An engine driven pump will be provided as a backup system in the event of an electrical outage and/or a mechanical pump failure. Both the temporary submersible and the engine driven pumps will be provided with temporary valves and piping located above ground that connect to the City's existing 8" bypass connected to the 18" force main downstream of the force main's isolation valve. This temporary system will be in operation for 3 to 4 months during the demolition of the existing pumps and piping system and construction of the new inlet sewers, wet well and submersible pump system.

Several new manholes and new gravity sewers will be required in Sawtelle Boulevard adjacent to the station to redirect flows to the new wet well. The footprint of the wet well and the design of the new sewers and manholes are constrained by existing utilities in Sawtelle Boulevard. An existing 8" gravity sewer flowing southerly in Sawtelle Boulevard is in conflict with a proposed new manhole. This line needs to be kept in service during construction and will be diverted temporarily to the existing wet well during construction. Once the new wet well is ready to provide the sewer pumping service, the existing sewers not to be used will be slurry filled and abandoned in place. A summary of all the necessary improvements and station modifications will be provided in Section 3 of this report.

II. STATION CAPACITY & HYDRAULICS

A. Station Flow Capacity

The station's present configuration has three units that operate as a lead, lag and standby sequence. The pumping capacity of the units is difficult to determine due to the abnormal pump operation with cavitation and a reduced rate of flow. Therefore, the new station improvements will provide the flow capacity that meets the maximum projected flow requirements summarized in a flow study prepared in 1992 for the Braddock Lift Station. The flow study indicates a required pumping capacity equal to 3340 gpm, as referenced in Appendix A of the report. Therefore, the two pumps units shall be selected to operate in parallel at a combined flow rate of 3340 gpm or 1670 gpm/each. However, if a single unit is operating, the pump will experience a lower total dynamic head (TDH) and move along the pump curve to provide a flow rate of approximately 1800 gpm.

B. Hydraulics

Table 1 summarizes the system hydraulics for the peak pumping rate of 3340 gpm and a single pump operation along with the flow rate from all three pumps operating in parallel. The TDH is the sum of static lift plus the force main friction loss plus the minor station losses from the piping and valves used to control the pump operation and isolate each of the units from the system. The TDH for the new submersible pump configuration at the peak flow is 72 feet with a pump rate of 1670 gpm per unit. A system head curve was plotted along with the one, two, and three pump performance curves. The intersection of the single pump performance curve with system head curve provides the actual performance of 1800 gpm with a TDH = 64 ft; the pump curve plotted for a two pump operation intersects the system head curve at 72 ft at a flow rate of 3340 gpm and the three pump operation plotted with the system head curve pumps at a rate of 4400 gpm with TDH = 81 feet. Exhibit No. 1 illustrates the system head curve plotted with the pump performance curves for a single, two and three-pump operation.

The new pump's performance requirements are higher than the existing units due to the deeper wet well. The existing station requires 30 Hp motors as compared to the new station, which will need 45 Hp motors. The existing Motor Control Center (MCC) will need to be upgraded with larger motor starters to meet the 45Hp motor requirement.

C. Pump Selection

The pumps selected by the City's staff were Wemco Hidrostal Pumps that are available for dry pit or submersible pumping configuration. A key factor for selecting the Wemco Pump was it's the high performance references from other agencies. This type of pump unit was identified as less problematic with clogging and ragging, which has been identified by the City's staff as problem experienced at the Braddock station. The pump proposed for the new station is the Wemco Hidrostal Model No. F6K-M Submersible/Immersible unit operated at a speed of 1755 rpm with 77.7% pump efficiency. Appendix B of the report has the pump performance curve and pump manufacturer literature for the pump slide rail system and piping connection for a wet well submersible installation.

The Wemco Hidrostal pump is also available in a pre-rotation configuration and Operation. In a pre-rotation system, one pump is placed lower than the others in a pre-rotation basin. This configuration allows the well level to be pumped low and carry solids to the lower pump. The pre-rotation basin causes the flow to rotate before entering the pump keeping sediment suspended and enhancing the solids passing capability of the pump. This type of operation would more readily pass solids and reduce sediment build-up in the wet well. The pre-rotation configuration will require the wet well to be constructed 18" Deeper creating additional cost. Additionally, a pre-cast pre-rotation basin and modified pump would be required. The additional estimated cost would be $40,000 to $50,000 for installing one of three units as a pre-rotation unit. The pre-rotation pump brochure and manufacturer's information is provided in Appendix C. The pump operation would be normally operated with the start/stops for all three pumps. The pre-rotation pump unit would be either manually operated by the operator on a daily or weekly bases or a timer basis that would pump the well 30" lower than normal to remove the collected solids from the wet well.

D. Pump Net Positive Suction Head (NPSH)

NPSH is a critical component of all pumps that needs to be analyzed with the field installation improvements. The pump manufacturer has provided pump performance curves that illustrate NPSH requirements at the various flow rates. A pump operation requires that the $NPSH_R$ (Required) is less than $NPSH_A$ (Available). Otherwise, the pump experiences cavitation. The $NPSH_A$ is determined by the pump's installation configuration and the pump's operation. The $NPSH_A$ considers the gravitational force acting on the fluid being pumped, based on the elevation of the pump compared to sea level, the temperature of fluid being pumped, the difference of the fluid level in the well compared with the elevation of the impeller and the friction losses for the pumped fluid experienced between the well and the pump's impeller. The proposed pump system's $NPSH_A$ easily exceeds the $NPSH_R$ for the proposed submersible pump configuration.

Additionally, as identified in the preliminary evaluation for the project, the existing pumps and configuration would be analyzed for the pump's NPSH. The evaluation determined that the existing pump's $NPSH_A$ was higher than the $NPSH_R$. However, the well's collected solids around the inlet piping as well as the close installation of the inlet piping in the well, actual losses could not be determined for this analysis. Therefore, the calculation of the existing station's $NPSH_A$ cannot be finalized for the existing pumps.

III. PROJECT IMPROVEMENTS

A. Summary of the Facility Improvements

The proposed project improvements are illustrated in Exhibit No. 2. Exhibit No. 2 shows the proposed new wet well and submersible pumps with the existing dry well vault converted into a valve vault to house the pump check and isolation valves required to control and isolate each of pump units. Additionally, Exhibit No. 2 illustrates the new inlet sewer alignment to convey the sewage flows to the new wet well. The new sewer will be constructed from the new manholes that will be constructed around the existing sewer pipelines that will maintain the service during the entire project and be capable of transferring the flow direction into the new system once the new wet well and pumps are constructed. The new 24" sewer would convey the sewage demands to the new wet well as shown in Exhibit No. 2. Exhibit No. 3 provides a section of the new wet well/submersible pumps and inlet sewer crossing under the existing 16" oil line and 6" MCI conduit. The section also illustrates the existing dry well modification that removes the existing pumps and modifies the piping and valve configuration to operate with the new submersible pump units. The section provides a view of the minimum clearance of 3.5 ft between the existing MCI conduit and the proposed wet well's exterior wall. This is the minimum space necessary to shore the new wet well forms used for the construction of a 30 ft. deep wet well structure without relocating the existing MCI conduit. The section also illustrates the depth of the new wet well with the pump control levels compared to the inlet sewer elevation. Appendix D provides the plan and section of the existing BSLS improvements that will be removed for the new improvements.

The other improvements shown in Exhibit No. 2 include modifications to the existing MCC/control system and a new meter in a 6' x 6' vault. Both the new meter and control system will be installed during the station's temporary bypass pump period to avoid any potential outages. The existing generator will not require any improvements, as the 150 kW capacity is adequate to provide the emergency backup power supply for the 2 –45 hp motors, plus the auxiliary demands to control the station.

As identified in Section II.C Pump Selection, the pre-rotation pump installation configuration would lower the wet well another 18" in order to utilize the self-cleaning operation. The basin is pre-casted by the manufacturer for installation in the wet well. Exhibit Nos. 2 & 3 do not illustrate the additional improvements required for the prerotation pump unit.

B. Wet Well Sizing and Configuration

The wet well configuration is shown in Exhibit Nos. 2 and 3 with the inlet sewer and pump control levels that conform to HIS and typical pump installations. The wet well volume is determined by limiting the pumps on/off cycles to 6 cycles per hour to prevent abnormal wear on the pumps and premature failure of units. The operation volume of the wet well is determined by the following equation:

$$\text{Wet Well Volume (max)} = \frac{\text{Q pump gpm}}{7.48\ \text{gal/cf}} \times \frac{10\ \text{minutes/cycle}}{4}$$

$$\text{Sump Volume (max)} = \frac{3340\ \text{gpm}}{7.48\ \text{gal/cf}} \times \frac{10\ \text{minutes/cycle}}{4} = 1116.3\ \text{CF}$$

The wet well is limited to a dimensions equal to 6.5 ft wide by 32 ft long, requiring an operation volume of 5.4 ft to prevent excessive start/stop pump cycles. Exhibit No. 3 illustrates the inlet sewer elevation, the wet well control levels, and the pump installation requirements for this application, including the wet well depth of 30 feet deep to accommodate all the requirements.

C. Construction Sequence of Work

The sequence of work will require the contractor to secure the equipment and delivery dates as the first order of work for all the new equipment. This will include the pumps, valves, piping, flow meter, hatches, manhole frame and covers, precast manholes and vault, MCC, and Control equipment. Since the pumps and motors are the longest delivery items, it is recommended that the City pre-order the pump units during the design phase of the project. This would save a minimum of two months delay for the delivery of the pump units during the construction phase. The contractor will be required to prepare a detailed construction schedule demonstrating the construction windows of the various phases of improvements with the procurement and installation of the equipment in a sequence of events that will maintain a continuous pumping operation at the station's rated capacity and complete the construction within the contract's required timeline.

IV. PROJECT SCHEDULE

The Project Schedule (Exhibit No. 4) provides an anticipated timeline for all three phases of the project, which includes the preliminary design, final design and construction phases. The present schedule has set the start of the final design in February 2009 and final plans and specifications ready for bidding with contractors by the first week of June 2009. A proposed bid opening is scheduled for the second week of July and award of the contract by the first week of August 2009. The estimated construction completion is set for June 30, 2010 given that the pumps are pre-ordered by the City for the contractor. Also, to reassure the City that the project will be completed within the allot time and all construction be performed with high quality construction methods and procedures, it is suggested that the city consider a pre-qualified list of contractors that have completed similar projects in the recent past be requested to bid the project. The list would be limited to 5 or 6 general contractors.

The contractor will be required to submit a construction critical path summary and a detailed project schedule that illustrates all construction methods and special operations/procedures required to complete the project. Project coordination with the City's staff, Contractor and Design Engineer will be paramount to the successful completion of the project.

V. ESTIMATED PROJECT COSTS

Table 2 summarizes the preliminary estimated construction cost for the proposed improvements and for maintaining the facility's continuous operation. The project's estimated construction cost is $1,900,000 and includes a 15 % contingency factor due to the difficult construction and sequence of work. The project will be reviewed with a general contractor capable of meeting all of the special construction requirements in order to confirm the estimated construction cost prior to the completion of the design plan preparation phase. The project would have an additional $40,000 to $50,000 costs for the prerotation pump installation not included with the estimated construction costs. The engineering design and construction assistance fees are estimated $130,000 to $150,000, plus the geotechnical engineer's fee.

VI. RECOMMENDATIONS

PRP Engineering, Inc. recommends that the City authorize the project's Phase II services based on the PDR highlighted requirements and the City staff's final PDR comments. A request for proposal would need to be issued by the City first week of January 2009 and design contract would be awarded by the second week of February 2009.

Table 1

City of Culver City

Braddock Sewage Lift Station

Hydraulic Summary

	Velocity	Single Pump	Two Pumps	Three Pumps
Operating Capacity (gpm)		**1800**	**3340**	**4440**
Stations Minor Losses (ft)				
2-8" 90 deg Elbows	11.5/10.6/9.4	3.3	2.8	2.2
8"Check Valve		3.5	3.0	2.2
12" Plug Valve	5.1/4.7/4.2	0.4	0.3	0.2
18 LF 8" FM Pipe	55/47/39/1000	1.0	0.8	0.7
12x16x16 wye	5.1/4.7/4.2	1.2	1.0	0.8
Miscellaneous Loss		0.5	0.7	0.9
Station Total Minor Losses		**9.9**	**8.6**	**7.0**
High Point 18" Force Main		**61.8**	**61.8**	**61.8**
Pump On Level		**13.0**	**13.5**	**14.0**
Static Lift (ft)		**48.8**	**48.3**	**47.8**
59 LF 16" FM pipe	**1.9/5.8/10.1**	**0.1**	**0.3**	**0.6**
4,581 LF 18" FM pipe	**1.1/3.2/5.5/1000'**	**4.9**	**14.6**	**25.2**
2 –18" Gate Valves K=0.19		**0.1**	**0.2**	**0.2**
Minor Loss		**9.9**	**8.6**	**7.0**
TDH (Ft)		**63.8**	**72.0**	**80.8**
18-inch FM Velocity (ft/sec)		**2.3**	**4.2**	**5.9**
Number of Pump units		**1**	**2**	**3**
Pump Rate Each (gpm)		**1800**	**1670**	**1480**
Pump Operating Speed (RPM)		**1755**	**1755**	**1755**
Pump Efficiency (%)		**78.5**	**77.7**	**77.0**
Actual Pump HP Requirement			**38.75**	
Pump Motor Size HP		**45.0**	**45.0**	**45.0**

TABLE 2

City of Culver City

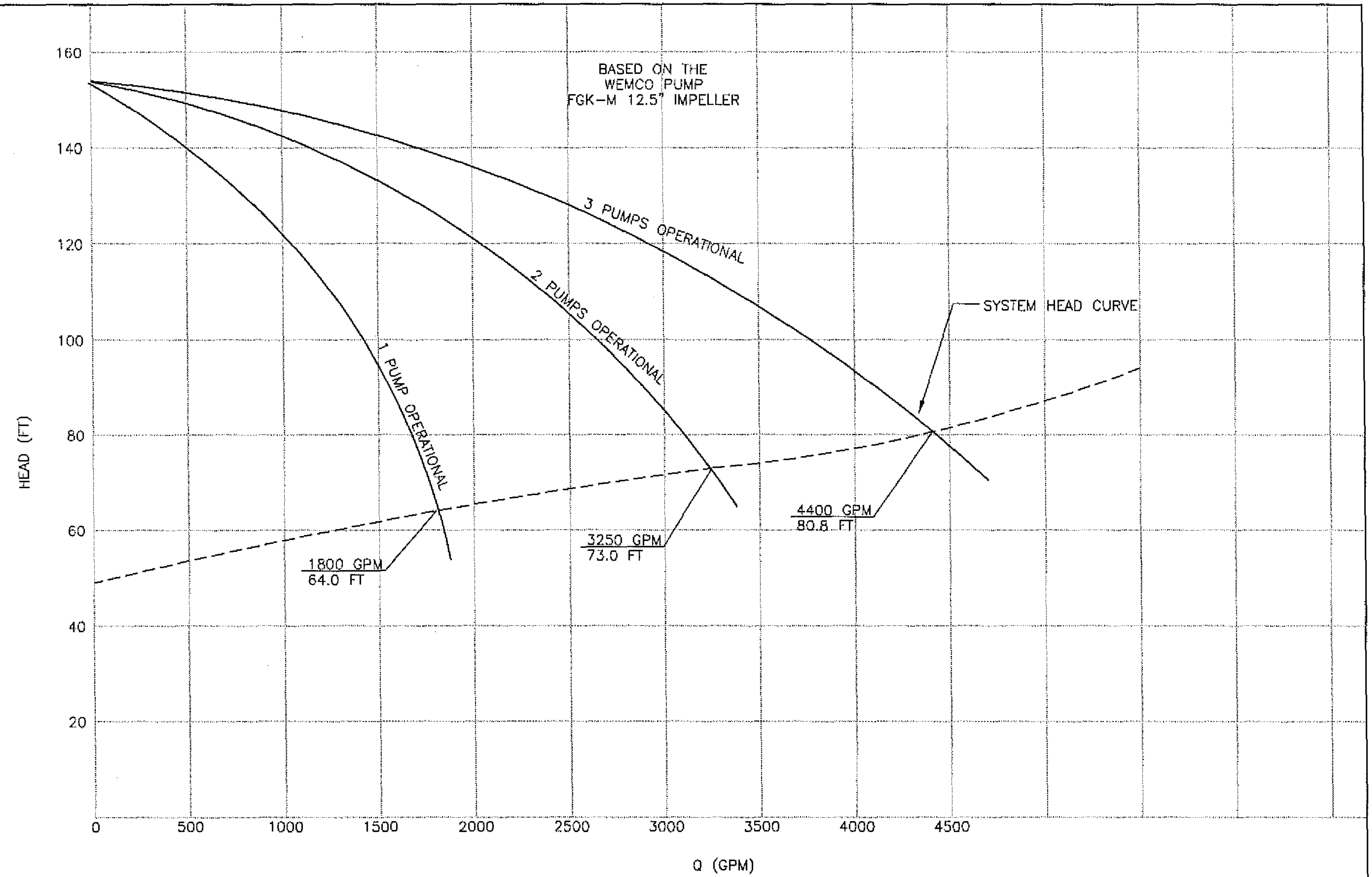
Braddock Lift Station
Upgrades & Improvements

Preliminary Design Report

Estimated Construction Cost

Item No.	Description	Quantity	Unit	Unit Cost ($)	Estimated Cost ($)
1	Site Work[1]	1	LS	$ 25,000	$ 25,000
2	Onsite Piping 24" Sewer [2]	115	LF	$ 2,400	$ 276,000
3	Onsite Piping 10" Sewer	44	LF	$ 200	$ 8,800
4	60" Diameter Manholes	2	Ea	$ 12,200	$ 24,400
5	48" Diameter Manholes	1	Ea	$ 4,500	$ 4,500
6	Electrical MCC for 3 - 45 Hp Motors & Pull Boxes	1	LS	$ 75,000	$ 75,000
7	New Wet Well Sonic Level & Control System	1	LS	$ 60,000	$ 60,000
8	New Wet Well Structure & Shoring w/ Excavation [3]	1	LS	$ 550,000	$ 550,000
9	Temporary By-Pass Pumping Systems [4]	4	Months	$ 35,000	$ 140,000
10	Wemco Pumps w/ Slide Rail Assembly Installed	3	Ea	$ 85,000	$ 255,000
11	Spare Wemco Pump	1	LS	$ 50,000	$ 50,000
12	8" Check Valves	3	Ea	$ 8,500	$ 25,500
13	12" Plug Valves	3	Ea	$ 6,000	$ 18,000
14	Discharge Piping, Supports, Couplings & Pressure Sensor	1	LS	$ 33,000	$ 33,000
15	16" Magnet Flow Meter & Vault	1	LS	$ 35,000	$ 35,000
16	Demolition & Disposal of the Exisitng Pump, Piping & MCC [5]	1	LS	$ 32,000	$ 32,000
17	Abandon the Existing Wet Well, 10" & 18" Sewers [6]	1	LS	$ 40,000	$ 40,000
	Estimated Total Costs				**$ 1,652,200**
	Contingencies @ 15%				**$ 247,800**
	Total Construction Cost				**$ 1,900,000**

[1] Site work includes the cost for the replace of exisitng retaining wall, sidewalk curb and gutter and street improvements over the wet well.
[2] 24" sewer is approximately 20 ft deep w/in the public R/W and will require shoring for installation.
[3] Costs includes the new wet structure & the interior lining of the wet well with T-Lock plus the costs for excavation, forms and shoring. The costs also include the dewatering and traffic control for constructing the facility in the street R/W.
[4] The costs includes the temporary pump system w/ controls & temporary above ground piping & valve system to bypass the existing flows from the station for approximately 4 months.
[5] The costs include the removal and disposal of the three existing pumps with suction and discharge piping & valves & the existing MCC.
[6] The costs includes the slurry backfill into the existing sewer and wet well to abandon the system sewer & wet well remove from service.



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prp engineering, inc.

WATER AND WASTEWATER ENGINEERS
15568 BROOKHURST ST. ,SUITE 185
WESTMINSTER, CA. 92683 (714) 374-0048

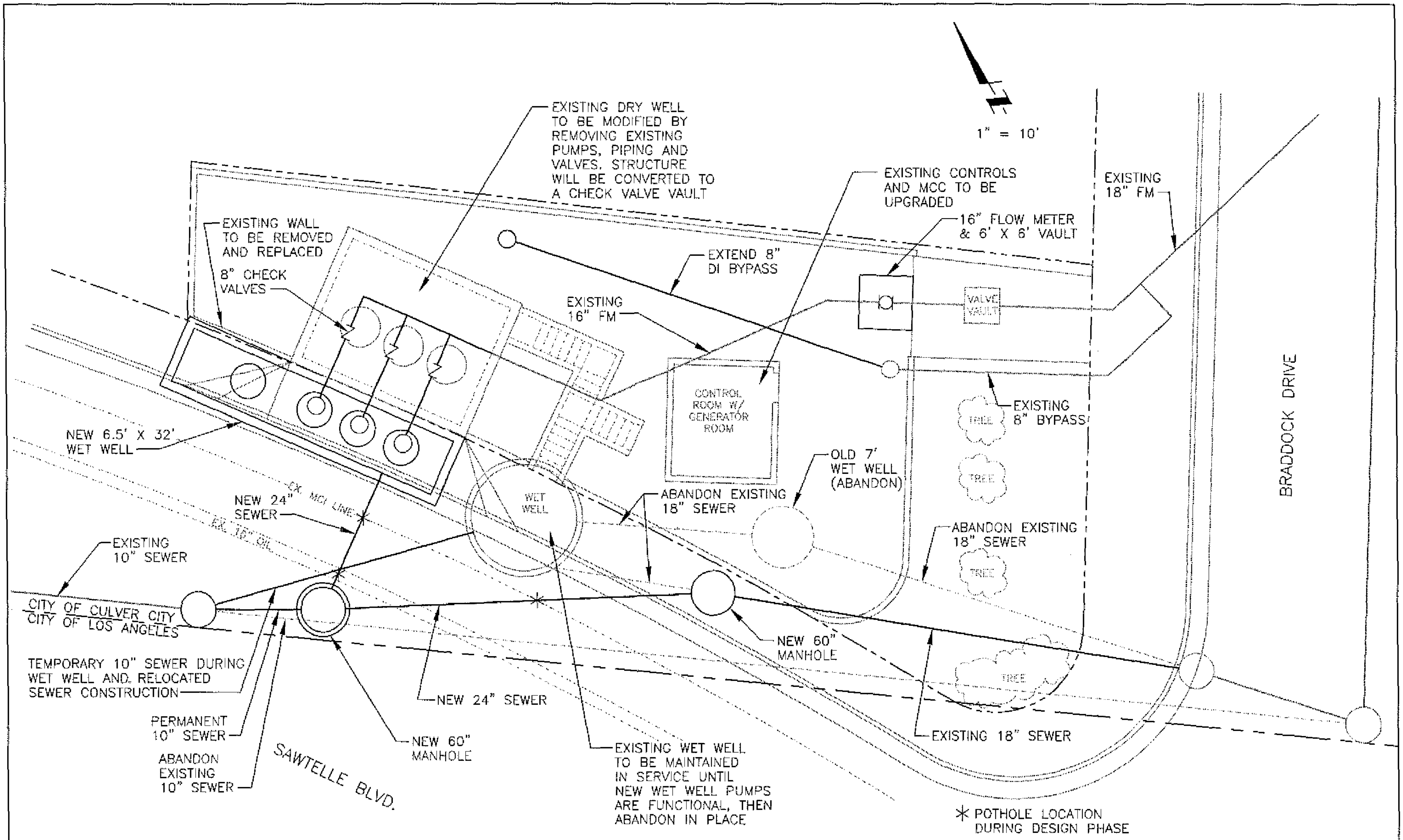
CITY OF CULVER CITY

BRADDOCK LIFT STATION
PUMPING SYSTEM IMPROVEMENTS

PUMP/SYSTEM HEAD CURVE

EXHIBIT NO.

1



prp engineering, inc. WATER AND WASTEWATER ENGINEERS 15568 BROOKHURST ST. ,SUITE 185 WESTMINSTER, CA. 92683 (714) 374-0048	CITY OF CULVER CITY BRADDOCK LIFT STATION PUMPING SYSTEM IMPROVEMENTS SITE LOCATION PLAN	EXHIBIT NO. 2

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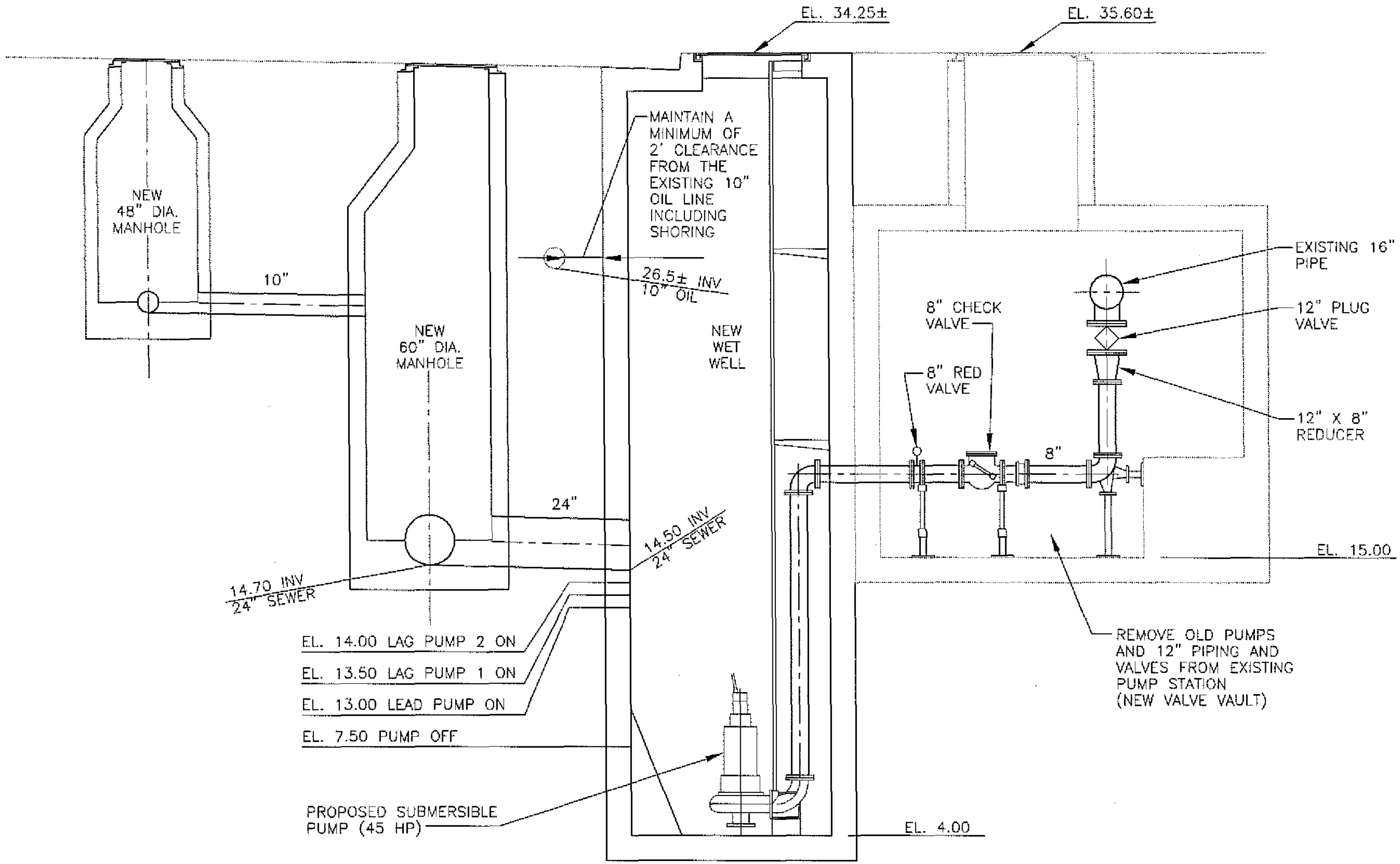

SECTION

1/4" = 1'-0"

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prp engineering, inc.

WATER AND WASTEWATER ENGINEERS
15568 BROOKHURST ST., SUITE 185
WESTMINSTER, CA. 92683 (714) 374-0048

CITY OF CULVER CITY

BRADDOCK LIFT STATION
PUMPING SYSTEM IMPROVEMENTS

SECTION

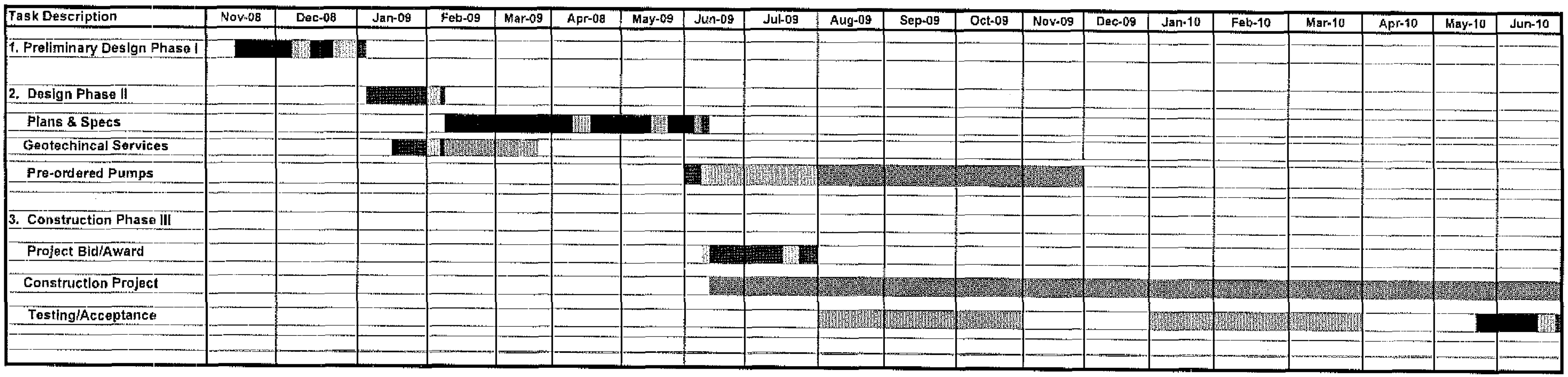
EXHIBIT NO.

3

Exhibit No. 4

City of Culver City
Braddock Sewage Lift Station Improvments

Design/Construction Project Schedule



Legend:

- Engineer
- City Staff
- Contractor
- Geotechincal Engineer
- Proposal /Bid Period
- Submittal
- City Approval/Award

APPENDIX A

City Flow Study for Braddock Lift Station

SECTION 4

WASTEWATER CHARACTERISTICS

4.1 - General

There are many variables which affect the quantity of wastewater that is generated in a particular community. The volume of sewage varies with the nature of development in the area, the intensity of the development, economic conditions, and many other factors. Moreover, the advent of many modern household conveniences has contributed to increased wastewater flows. The result is that there are no "standard" unit flow factors which are applicable to all urban areas in all communities.

While there are several approaches that may be employed to predict and calculate the sewage flows from an area, the most widely used is the Uniform Peaking Curve Method (UPCM). The Los Angeles County and Orange County Sanitation Districts basically use the UPCM approach, and it has been adopted for use in this study.

This approach utilizes one peaking curve reflecting the typical peak flows that may be anticipated from any average flow. Average sewage flows are calculated from typical average unit flow coefficients such as gallons per day per acre. The peaking curve reflects the ratio of peak flow to average flow so that for any calculated average flow, a peak flow can be found on the curve. This peak flow is then used to size the sewers.

4.2 - Data Collection

Information from the City of Culver City Master Sewer Plan, June, 1970, and past flow records provided by the City were utilized as an aid in developing unit sewage flow characteristics. This data, together with available flow data from other representative cities in the area and the use of generally accepted engineering practices, was then used as a basis to determine unit flow coefficients and peaking factors for use in this study. Records from the City of Los Angeles were used to determine the existing flow rates generated by the City of Los Angeles that are tributary to the City of Culver City.

4.3 - Data Analysis

The unit flow coefficients and peaking factors shown in Table 4-1 and Table 4-2 respectively, were derived from the sewer flow data collected. The values for low and medium density residential areas are the same as those employed in the 1970 Master Sewer Plan, and are very similar to those used in other studies. The high density residential, commercial and manufacturing values have been adjusted to reflect the current type of businesses situated the City and are more typical for a municipality the size of Culver City.

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The peaking factors used for this study are significantly less than those used in the 1970 Master Sewer Plan. In general, the peaking factors from the 1970 study were approximately 40 percent larger than those used in this study, which in turn corresponds to a peak flow rate that is 40 percent larger.

TABLE 4-1

UNIT FLOW COEFFICIENTS FOR VARIOUS LAND USES

Land Use (Designation)	Average Unit Flow Coefficient	
Low Density Residential (R-1)	0.0026 cfs/ac	1,700 gpd/ac
Medium Density Residential (R-2,3)	0.0059 cfs/ac	3,800 gpd/ac
High Density Residential (R-4)	0.0075 cfs/ac	4,800 gpd/ac
Commercial District	0.0039 cfs/ac	2,500 gpd/ac
Manufacturing District	0.0047 cfs/ac	3,000 gpd/ac
Schools	0.0015 cfs/ac	1,000 gpd/ac
Hotels & Motels	0.0120 cfs/ac	7,750 gpd/ac

TABLE 4-2

PEAKING FACTORS

Average Flow Rate		
Gallons Per Day	Cubic Feet Per Second	Peaking Factor
3,000	0.0046	2.93
8,000	0.0124	2.71
15,000	0.0232	2.57
25,000	0.0387	2.47
40,000	0.0619	2.38
80,000	0.1238	2.25
140,000	0.2166	2.15
230,000	0.3559	2.07
370,000	0.5725	1.99
600,000	0.9283	1.92
1,000,000	1.5472	1.84
1,500,000	2.3208	1.78
2,300,000	3.5586	1.72
3,200,000	4.9511	1.68
4,200,000	6.4984	1.64
6,500,000	10.0570	1.58
9,000,000	13.9251	1.54
13,000,000	20.1140	1.50
18,000,000	27.8501	1.46
25,000,000	38.6807	1.42

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SECTION 5

MODEL DEVELOPMENT

5.1 - General

The model development phase of the project involved the establishment of a computerized mathematical model of the City's sewer system utilizing the information assembled in the earlier phases of the project. The purpose of the model development was to:

1. Develop a schematic of the existing sewer system network.

2. Compute the sewage flow tributary to each sewer main within the study area.

3. Analyze the existing sewer system using the computer model to determine the system's capability to convey the flows generated from the present and ultimate development of the study area, in accordance with the Zoning Map.

4. Identify the deficiencies in the system.

5. Establish a recommended deficiency correction program.

5.2 - Computerized Model of Sewer System

The sewer system network included in the computerized model was established in conjunction with the staff of the City of Culver City and was based on the data collection assembled in the initial phase of the project. The sewer system selected for modeling consists of all City owned sewers with the exception of the upstream portion of certain lines. The portions of the system that had less than 100 house connections at the upstream end of the line were not modeled, although the flows contributed by their service area were considered in the overall analysis.

The existing sewer system network was divided into drainage districts for input into the computer model. The districts are numbered and defined the same as those used in the 1970 Master Plan, with the following two exceptions: 1) District 9 was broken into two districts as a result of the Duquesne Avenue Relief Sewer being constructed in 1979. The two districts are referred to herein as Districts 9-West and 9-East (or (9W and 9E); 2) District 21 was broken into two districts as a result of the Overland Pump Station being constructed pursuant to that plan. The two districts are referred to herein as Districts 21-Mesmer and 21-Overland (or 21M and 21O). Those districts which are very small in size or contain little or no sewer improvements were not included in this study. The computer input consisted of a numerical designation for each manhole, the slope of the sewer line, and the size and roughness coefficient of the pipe. Sufficient information was

assembled to establish a schematic of the sewer system to be modeled.
The network established for modeling and the district boundaries are shown on Plate 1.

The capacity of the existing facilities was determined with the Manning Equation

$$Q = \frac{1.486}{n} AR^{2/3}S^{1/2}$$

Where:

Q = Flow rate in cfs
n = Manning's roughness coefficient
A = Pipe cross-sectional area in square feet
R = Hydraulic radius
s = Pipe slope

A Manning's "n" value of 0.013 was used for all sewers.

5.3 - Computation of Sewer Inflows

After establishing the schematic of the sewer system, data was compiled on the tributary drainage basins, land use and other factors which affect the volume of sewage generated. Through a review of the City's sewer record maps, it was possible to define the tributary drainage areas for the various sewer lines.

Once the study area was divided into drainage districts, it was necessary to compute the area of each type of land use. This was done for each area utilizing the present use of the land (existing), and also for fully developed conditions utilizing the most intense land use permissible in each zoning district (ultimate). The unit flow coefficients shown in Table 4-1, when applied to the land use areas, provide average flow rates for each particular land use category. It should be noted that even though a single value was used for the flow coefficient for each land use category, the rates will vary within each category depending upon specific use. The variations will be greatest in the commercial and manufacturing districts. Therefore, computed existing flows may deviate from actual recorded flows.

The computer program also applies the peaking factor established in Table 4-2 to the average sewage flow to determine the peak flow in each reach of the system. Since the design of sewer mains is based on peak, rather than average, flow rates, it is necessary to include the peaking factor adjustment in the flow calculations and analysis of the system.

The program further allows for the input of flows from point sources, in this case the flows accepted from the City of Los Angeles. The estimated sewer flows are accumulated totally within the computer program to provide the calculated average and peak flow for each link within or for the entire drainage district.

Table 5-1 summarizes the sewage flow data for each of the districts analyzed, and Table 5-2 compares the average and peak flow rate by district based on ultimate land use with the comparable values given in the 1970 report.

5.4 - Deficiency Criteria

The City's sewer system was modeled using Civilsoft's Sewer System Modeling program SEWER. The program is designed to provide capability for both the analysis of existing sewer systems and the design of new mains.

In the analysis of an existing sewer system, the SEWER program compares the capacity of each pipe in the system with the peak sewage flow projected for that particular link. If the existing pipe size is inadequate or under capacity, the program automatically calculates the required pipe size to either relieve or replace the deficient line. The pipe is considered deficient if the depth of flow at the predicted peak flow is greater than 75 percent of the pipe diameter. This additional capacity in the pipe is to allow for instantaneous or intermittent peaks, which usually occur between the hours of 6 and 9 o'clock in the morning on weekdays and 9 and 12 o'clock in the morning on weekends, and other factors.

Adjustments in the size of the sewer lines are only shown when an increase in the pipe diameter is required. Since the model represents existing pipe sizes, no decrease in pipe diameter is considered.

The depth of flow in the pipes are all based on normal depth calculations using the Manning Equation. If the depth of flow exceeds the pipe diameter, the system becomes surcharged and backwater effects will be created upstream, however these effects are not considered by the program. Therefore, other problems may exist upstream of the identified deficiencies. However, these would be eliminated if the noted downstream deficiencies were corrected.

5.5 - Sewer System Deficiencies

Once the mathematical model was established for the existing sewer system and the sewage flows for the system were computed, the existing system was analyzed. The computer printouts for all districts analyzed and an explanation of the output format are included in the appendices.

Table 5-3 shows the sewer system deficiencies based on the existing land use, and Table 5-4 shows the deficiencies based on ultimate land use criteria.

TABLE 5-1

SUMMARY OF SEWAGE FLOWS BY DISTRICT

Dist.	Contrib. Area (Acres)	Composite Flow Factor	Ave. Flow (cfs)	L.A. Flow (cfs)	Total Ave. Flow (cfs)	Peaking Factor	Peak Flow (cfs)
1-EU	54.9	0.00401	0.22	---	0.22	2.15	0.47
3-E	129.5	0.00417	0.54	---	0.54	2.00	1.08
3-U	129.5	0.00448	0.58	---	0.58	1.99	1.14
4-E	26.1	0.00421	0.11	0.390	0.50	2.01	1.01
4-U	26.1	0.00460	0.13	0.815	0.94	1.91	1.79
7-E	78.9	0.00672	0.53	0.003	0.53	2.00	1.06
7-U	78.9	0.00786	0.62	0.007	0.63	1.97	1.25
8-E	720.8	0.00373	2.69	1.030	3.72	1.71	6.36
8-U	720.8	0.00405	2.92	1.498	4.42	1.69	7.45
9E-E	241.9	0.00471	1.14	---	1.14	1.88	2.14
9E-U	241.9	0.00492	1.19	---	1.19	1.87	2.23
9W-E	90.3	0.00576	0.52	---	0.52	2.00	1.04
9W-U	90.3	0.00642	0.58	---	0.58	1.98	1.15
10-E	69.0	0.00362	0.25	---	0.25	2.12	0.54
10-U	69.0	0.00348	0.24	---	0.24	2.13	0.51
12-EU	18.9	0.00794	0.15	---	0.15	2.22	0.32
16-E	157.0	0.00484	0.76	---	0.76	1.94	1.47
16-U	157.0	0.00516	0.81	---	0.81	1.93	1.57
20-EU	77.4	0.00260	0.20	---	0.20	2.16	0.44
21O-E	154.7	0.00595	0.92	---	0.92	1.91	1.77
21O-U	154.7	0.00627	0.97	---	0.97	1.90	1.84
21M-E	477.9	0.00362	1.73	---	1.73	1.82	3.15
21M-U	477.9	0.00349	1.67	---	1.67	1.82	3.05
22-EU	54.8	0.00260	0.14	---	0.14	2.22	0.32
23-EU	93.0	0.00398	0.37	---	0.37	2.06	0.75
24-E	190.5	0.00577	1.10	---	1.10	1.89	2.08
24-U	190.5	0.00583	1.11	---	1.11	1.88	2.09
TOTALS							
E	**2635.6**	**0.00431**	**11.37**	**1.423**	**12.79**	**1.88**	**24.00**
U	**2635.6**	**0.00452**	**11.90**	**2.320**	**14.22**	**1.85**	**26.37**

E denotes existing, U denotes ultimate, and EU denotes both equal

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APPENDIX B

WEMCO HIDROSTAL PUMP
PERFORMANCE & INSTALLATION DATA

Weir Specialty Pumps
www.weirsp.com

WEMCO PUMP
WEMCO-HIDROSTAL
ROTO-JET PUMP

Pump Performance Datasheet

Customer	: FLO-SYSTEMS INC.	Quote number	: 67586
Customer reference	:	Pump size	: F6K-M Submersible/Immersible
Item number	: 001R	Stages	: 1
Service	: Raw Sewage	Based on curve number	: P25-D110
Quantity of pumps	: 3	Date last saved	: 25 Nov 2008 1:11 PM

Operating Conditions

Flow, rated	: 1,670 USgpm
Head, rated (requested)	: 71.5 ft
Head, rated (actual)	: 71.2 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: Ample
Frequency	: 60 Hz

Liquid

Liquid type	: User defined (no properties)
Additional liquid description	:
Solids diameter, max	: 0.00 in
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 0.998 / 0.998 SG
Viscosity, rated	: 1.00 cP
-	:

Performance

Speed, rated	: 1,755 rpm
Speed, maximum	: 1,800 rpm
Speed, minimum	: 850 rpm
Efficiency	: 77.68 %
NPSH required / margin required	: N/A / 0.00
Ns (imp. eye flow) / Nss (imp. eye flow)	: N/A US Units
MCSF	: 819 USgpm
Head maximum, rated speed	: 148 ft
Head rise to shutoff	: 107.37 %
Flow, best eff. point (BEP)	: 1,947 USgpm
Flow ratio (rated / BEP)	: 85.78 %
Speed ratio (rated / max)	: 97.50 %
Head ratio (rated speed / max speed)	: 92.87 %
Cq/Ch/Ce [ANSI/HI 9.6.7-2004]	: 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Material

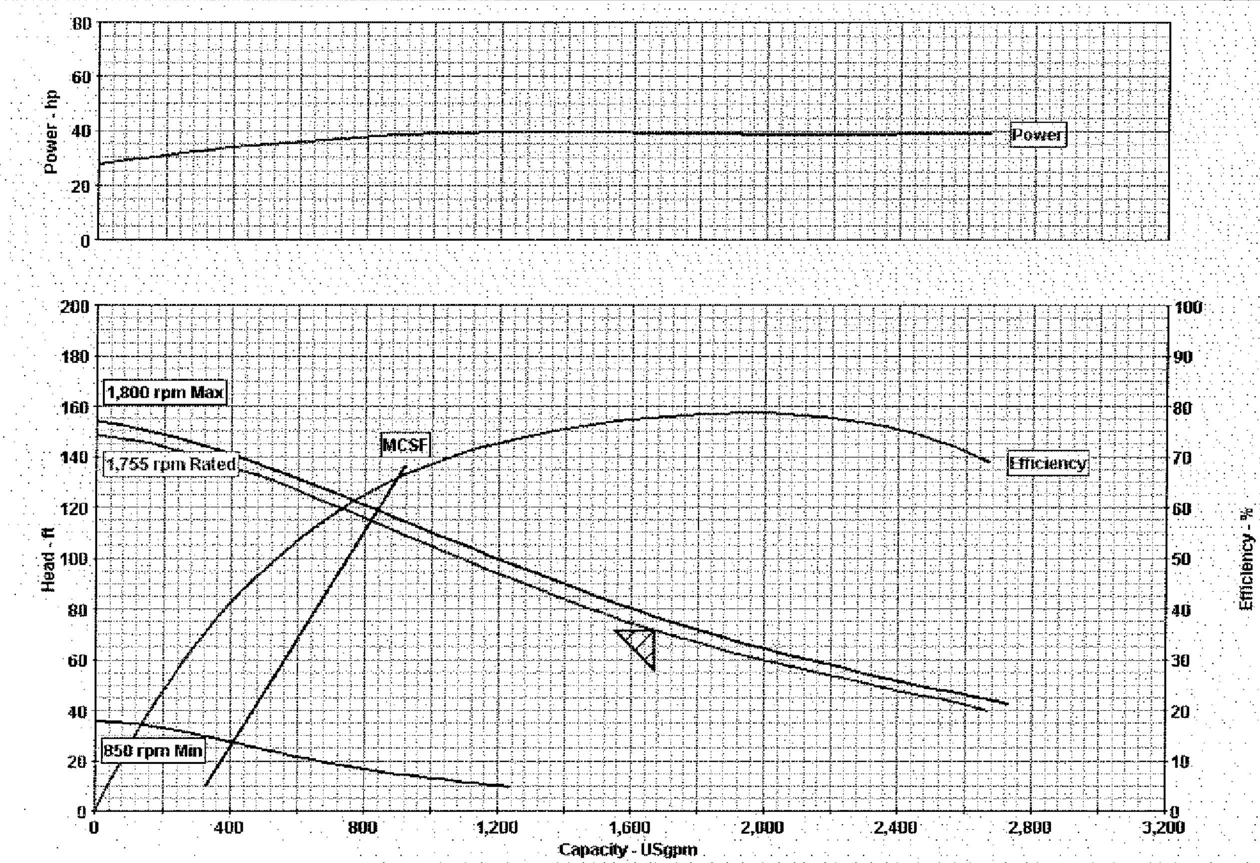
Material requested	: Standard
Material selected	: Standard

Pressure Data

Maximum working pressure	: 30.95 psi.g
Maximum allowable working pressure	: 95.00 psi.g
Maximum allowable suction pressure	: N/A
Hydrostatic test pressure	: N/A

Driver & Power Data

Driver sizing specification	: Rated power
Margin over specification	: 0.00 %
Service factor	: 1.00
Power, hydraulic	: 30.10 hp
Power, rated	: 38.75 hp
Power, maximum, rated speed	: 39.09 hp
Minimum recommended motor rating	: 40.00 hp / 29.83 kW



Construction Datasheet

Customer	: FLO-SYSTEMS INC.	Quote Number	: 67586
Project	:	Model / Size	: F6K-M Submersible/Immersible
Item number	: 001R	Stages	: 1
Service	: Raw Sewage	Pump speed	: 1,755 rpm
Quantity of pumps	: 3.0	Date last saved	: 25 Nov 2008 1:10 PM

Construction

Nozzle	Size	Rating (ANSI)	Face	Pos'n
Suction	8 in	125 lbs	FF	Left
Discharge	6 in	125 lbs	FF	Right

Impeller Type	: Screw-Centrifugal
Impeller Design	: Non-Clog
Pump Orientation	: Submersible
Bearing Type (Rad/Thr)	: Ball/Ball
Bearing Lubrication	: Grease
Rotation (view from wet-end)	: -

Materials

Casing	: Cast Iron
Impeller	: Ductile Iron
Liner	: High Chrome (regulable)
Elastomer	: Buna Wet End O-rings
Shaft	: -
Sleeve	: -

Baseplate, Connection and Guard

Baseplate Type	: Cast Iron Fastout / Steel Base
Baseplate Material	: Cast Iron
Orientation	: 30 foot cable
Connection Type	: -
Guard	: -

Weights (Approx.)

Bareshaft pump	: 450.0 lb
Baseplate	: 300.0 lb
Driver	: 600.0 lb
Total weight	: 1,500.0 lb

Driver Information

Manufacturer	: Hidrostal
Power	: 53.60 hp
Service factor	: 1.0
Speed	: 1760
Orientation / Mounting	: Submersible
Driver type	: Immersible
Frame-size	: FE4T4
Enclosure	: -
Hazardous area class	: CL, Div 1, Groups C & D
Explosion rating	: FM Approved
Volts / Phase / Hz	: -
Insulation	: Class F
Temperature Rise	: -
Motor mounted by	: WSP

Seal, Gland and Piping

Seal Arrangement	: -
Seal Size	: -
Manufacturer	: -
Gland Material	: -
Seal Face Mat'l	: -
Throat Bushing	: N/A
Seal Flush Plan	: -
Seal Flush Construction	: -

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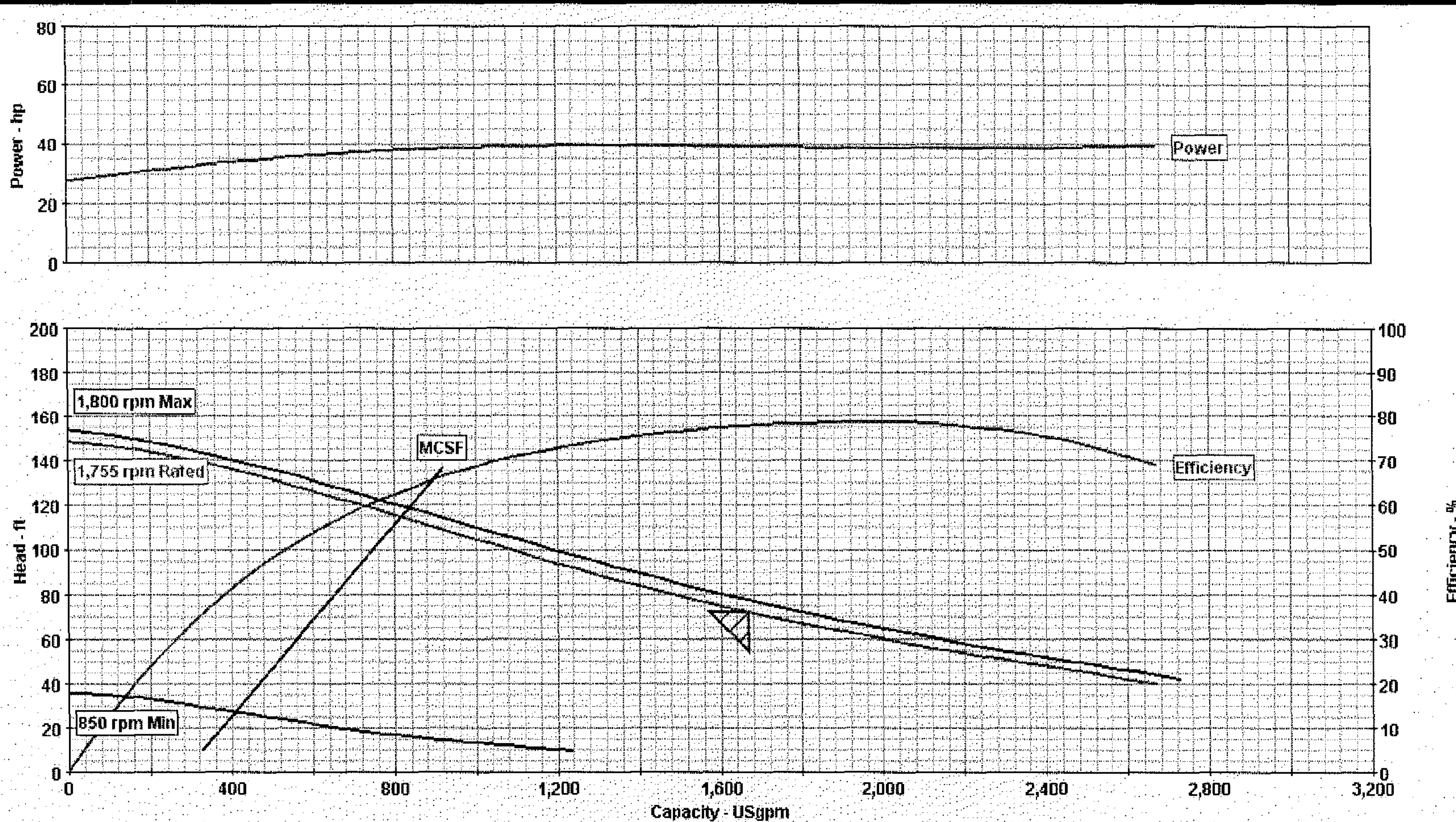
Pump Performance Curve



Customer	: FLO-SYSTEMS INC.	Pump size	: F6K-M Submersible/Immersible	Flow, rated	: 1,670 USgpm
Customer reference	:	Stages	: 1	Head, rated	: 71.5 ft
Item number	: 001R	Pump speed, rated	: 1,755 rpm	Fluid density, rated / max	: 0.998 / 0.998 SG
Service	: Raw Sewage	Based on curve number	: P25-D110	Viscosity	: 1.00 cP
Quantity of pumps	: 3	Efficiency	: 77.68 %	Cq/Ch/Ce [ANSI/HI 9.6.7-2004]	: 1.00 / 1.00 / 1.00
Quote number	: 67586	Power, rated	: 38.75 hp	-	
Date last saved	: 25 Nov 2008 1:11 PM	NPSH required	: N/A	-	

General Arrangement Drawing

Customer	: FLO-SYSTEMS INC.	Quote number	: 67586
Customer reference	:	Pump size	: F6K-M Submersible/Immersible
Item number	: 001R	Stages	: 1
Service	: Raw Sewage	Pump speed	: 1,755 rpm
Quantity of pumps	: 3.0	Date last saved	: 25 Nov 2008 1:10 PM

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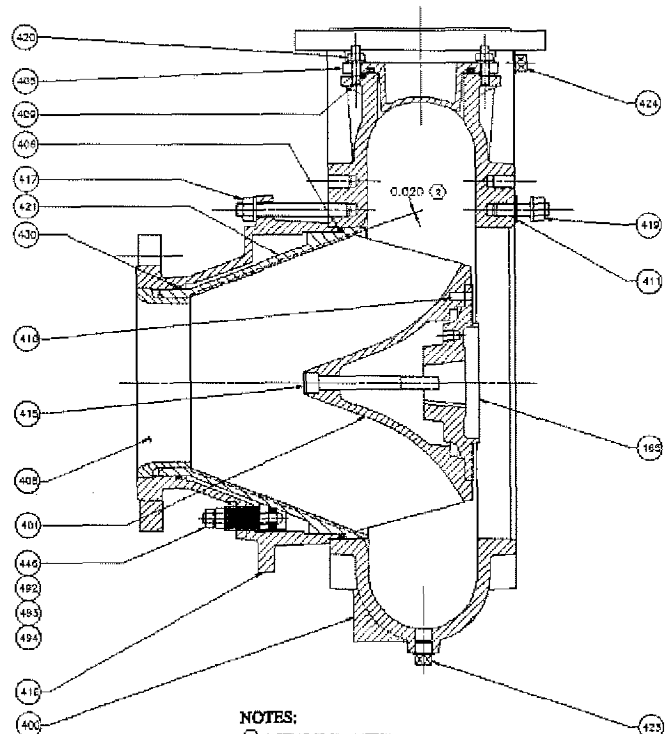
79386



L QTY	M QTY	H QTY	S QTY	ITEM NO.	PART NO.	DESCRIPTION	RAW PART NO.	MATL	UNIT WT.
1	1	1	1	165	71828-*	FLANGE, IMPELLER (F25/F2W BEARING FRAME)		1	
1	1	1	1		79413-*	FLANGE, IMPELLER (F46 BEARING FRAME)		1	
1	1	1	1	400	70014-*	CASING, VOLUTE		1	145
			1	401	70281-*	IMPELLER, F6K-S		1	54
		1			70079-*	IMPELLER, F6K-H		1	54
	1				70080-*	IMPELLER, F6K-M		1	54
1					70078-*	IMPELLER, F6K-L		1	54
1	1	1	1	402	70439-*	COVER, HANDHOLE		1	6
1	1	1	1	406	142338	O-RING, 3.0 X 345mm		BUNA-N	
1	1	1	1	408	70414-*	RING, WEAR		1	
1	1	1	1	409	142336	O-RING, 7.0 X 115mm		BUNA-N	
1	1	1	1	410	178034	PIN, DOWELL 8mm X 16mm		STL	
1	1	1	1	411	71860-2	SHIM KIT		STL	
		1	1	415	414664	BOLT, IMPELLER, M16 X 100mm		316 SST	
1	1				414534	BOLT, IMPELLER, M16 X 100mm		316 SST	
		1	1	416	70299-*	CASING, SUCTION		1	
1	1				70298-*	CASING, SUCTION		1	
		8	8	417A	421530	STUD, TAP END M16 X 100mm	3	STL	
		8	8		421531	STUD, TAP END M16 X 100mm	3	316 SST	
8	8				421701	STUD, TAP END M16 X 40mm	3	STL	
8	8				421702	STUD, TAP END M16 X 40mm	3	316 SST	
8	8	8	8	417B	40629	NUT, HEX M16 X 2.0	3	STL	
8	8	8	8		44133	NUT, HEX M16 X 2.0	3	316 SST	
8	8	8	8	417C	233025	WASHER, PLAIN 5/8	3	STL	
8	8	8	8		233020	WASHER, PLAIN 5/8	3	316 SST	
8	8	8	8	419A	421701	STUD, TAP END M16 X 40mm	3	STL	
8	8	8	8		421702	STUD, TAP END M16 X 40mm	3	316 SST	
8	8	8	8	419B	40629	NUT, HEX M16 X 2.0	3	STL	
8	8	8	8		44133	NUT, HEX M16 X 2.0	3	316 SST	
8	8	8	8	419C	233025	WASHER, PLAIN 5/8	3	STL	
8	8	8	8		233020	WASHER, PLAIN 5/8	3	316 SST	
2	2	2	2	420A	420941	STUD, TAP END M10 X 35mm	3	STL	
2	2	2	2		420942	STUD, TAP END M10 X 35mm	3	316 SST	
2	2	2	2	420B	44866	NUT, HEX M10 X 1.5	3	STL	
2	2	2	2		20870	NUT, HEX M10 X 1.5	3	316 SST	
2	2	2	2	420C	232535	WASHER, PLAIN 3/8	3	STL	
2	2	2	2		232520	WASHER, PLAIN 3/8	3	316 SST	
		1	1	421	70306-*	LINER		4	
1	1				70308-*	LINER		4	
1	1	1	1	423	232360	PLUG, PP SQ HD 1/2NPTM	3	STL	
1	1	1	1		242400	PLUG, PP SQ HD 1/2NPTM	3	316 SST	
1	1	1	1	424	232360	PLUG, PP SQ HD 1/2NPTM	3	STL	
1	1	1	1		242400	PLUG, PP SQ HD 1/2NPTM	3	316 SST	
1	1	1	1	430	142209	O-RING, 5.0 X 215mm		BUNA-N	
3	3	3	3	446	70460-A	NUT, REGULATOR		316 SST	
3	3	3	3	492	421251	STUD, TAP END M12 X 1.75 X 80		316 SST	
3	3	3	3	493	43879	NUT, HEX M12 X 1.75		316 SST	
3	3	3	3	494	20073	WASHER, LOCK M12		316 SST	

NOTES:

1. MATERIALS OF CONSTRUCTION:
   -1 = CAST IRON (FOR VOLUTE & SUCTION CASING ONLY)
   -2 = 316 SST
   -3 = CAST IRON (FOR IMPELLER ONLY)
   -7 = HI-CHROME (FOR IMPELLER & LINER ONLY)
2. SET IMPELLER CLEARANCE TO 0.020" MAXIMUM. CLEARANCE SHOULD BE CHECKED ALONG ENTIRE IMPELLER EDGE AND AGAIN AFTER ROTATING IMPELLER 1/4, 1/2 AND 3/4 TURNS.
3. FASTENER MATERIALS PER APPLICATION.
4. MATERIAL AND MACHINING PER APPLICATION.

ITEM 406 P/N 142338 WAS 142397 — 52454

WEMCO PUMP — SALT LAKE CITY, UTAH

WET END ASSEMBLY F6K REGULABLE

WEMCO-HIDROSTAL PUMPS

SCALE 1:2 — D — 79386

DIMENSIONS ARE IN INCHES

General Arrangement Drawing

Customer	: FLO-SYSTEMS INC.	Quote number	: 67586
Customer reference	:	Pump size	: F6K-M Submersible/Immersible
Item number	: 001R	Stages	: 1
Service	: Raw Sewage	Pump speed	: 1,755 rpm
Quantity of pumps	: 3.0	Date last saved	: 25 Nov 2008 1:10 PM

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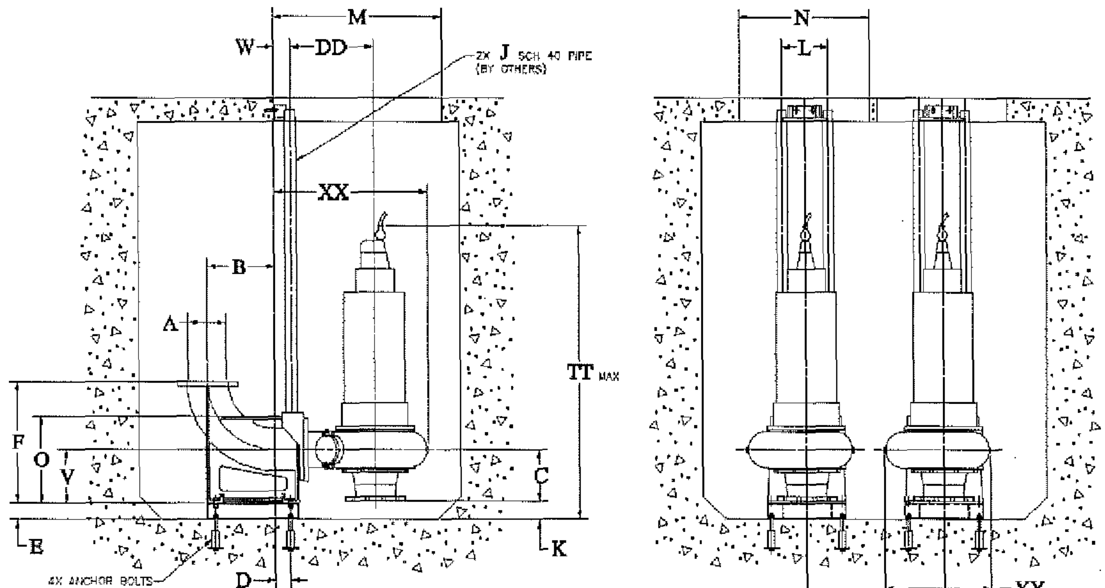
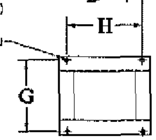
PUMP	FAST-OUT TYPE	A	B	C	D	E	F	G	H	I	J=PIPE SIZE	K	L	M	N	O	S	TT	V	W	DD	XX	YY
F4K	4 X 6	6	7 1/2	9 5/8	2 9/16	–	20 11/16	9 1/16	11 7/16	3/4	1 1/2	3 3/16	3 3/16	36	26	17 15/16	27	66 1/4	12 13/16	2 3/8	19 7/8	33 1/16	23 1/4
F6K-M	6 X 8	8	9 13/16	10 5/8	2	7 7/8	19 11/16	10 1/4	11 13/16			4 5/16			30	12 3/16	31	69 1/2	7 1/16		18 7/8	33 7/8	27 3/16
F6K-H,-S				13		10 5/8						4 3/4						75 5/16					
F10K	10 X 10	10	17 3/4	13 3/8	4 1/8	4 1/4	31 1/2	18 1/2	19 11/16	7/8	2 1/2		12 3/16	44	34	22 7/16	38	76 5/16	13 13/16	4 5/16	21 3/4	40 7/16	31 7/8





NOTES:

1. DIMENSIONS ARE NOT FOR INSTALLATION PURPOSES UNLESS CERTIFIED.
2. PUMP AND ACCESSORIES ARE DESIGNED FOR CONTINUOUS SERVICE.
3. PUMP SIZE, MODEL AND SERIAL NUMBER MUST BE SPECIFIED WHEN ORDERING SPARE PARTS.
4. CLOCKWISE ROTATION VIEWED FROM SHAFT END; CCW IS NOT AVAILABLE.
5. SUCTION AND DISCHARGE FLANGE MATE WITH CLASS 125 FLANGES.

EnviroTech PUMPSYSTEMS
WEMCO PUMP

GENERAL ARRANGEMENT
F4K, F5K & F10K IMMERSIBLE
WITH FAST-OUT
WEMCO-HIDROSTAL PUMP

DRAWN BY JJJ 9-10-01
ENG'G ERG 5-14-01
APPROVED ERG 5-14-01
SHEET 1 OF 1
SCALE 1:12 SIZE D DWG NO. 700154 –

30

Weir Specialty Pumps
www.weirsp.com

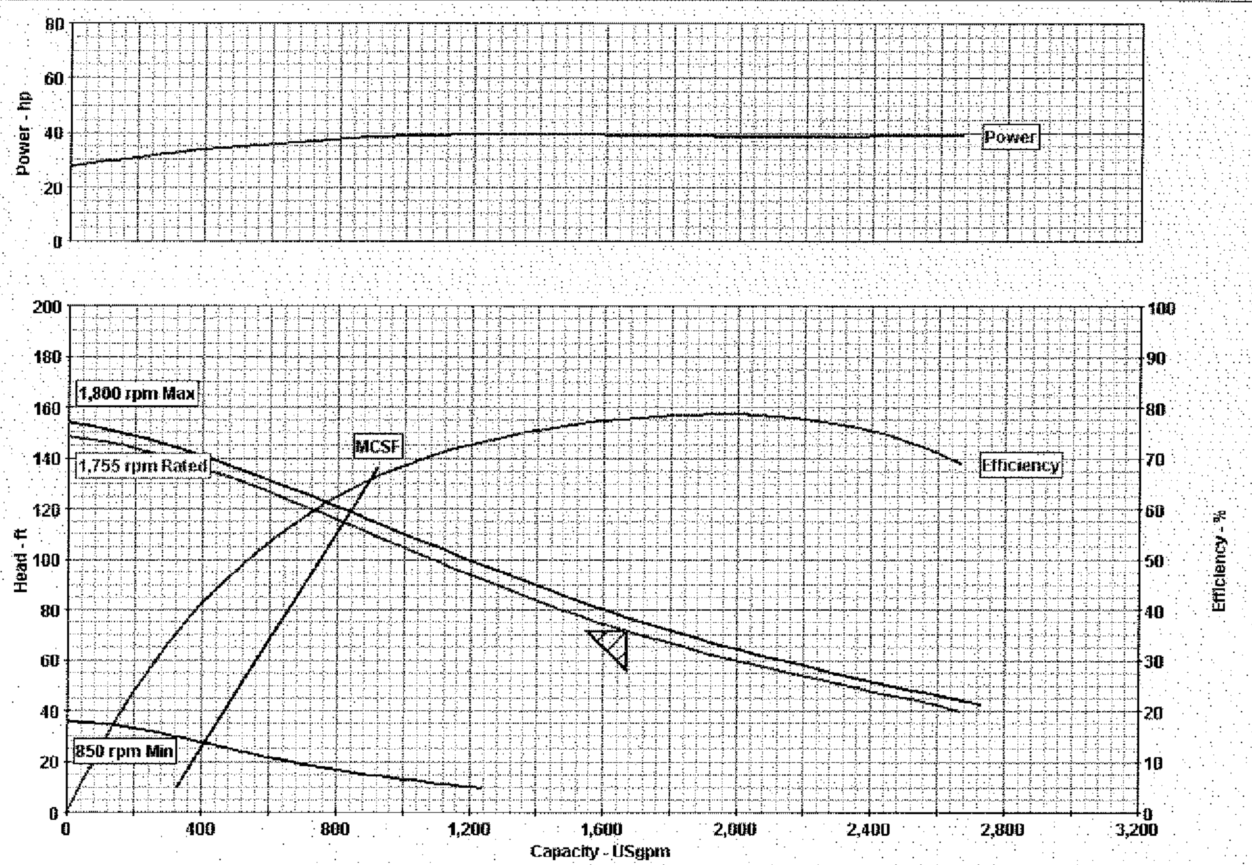
WEMCO PUMP®
WEMCO-HIDROSTAL
ROTO-JET PUMP

Pump Performance Datasheet

Customer	: FLO-SYSTEMS INC.	Quote number	: 67586
Customer reference	:	Pump size	: F6K-M
Item number	: 001R-A	Stages	: 1
Service	: Raw Sewage	Based on curve number	: P25-D110
Quantity of pumps	: 3	Date last saved	: 25 Nov 2008 1:19 PM

Operating Conditions		Liquid	
Flow, rated	: 1,670 USgpm	Liquid type	: User defined (no properties)
Head, rated (requested)	: 71.5 ft	Additional liquid description	:
Head, rated (actual)	: 71.2 ft	Solids diameter, max	: 0.00 in
Suction pressure, rated / max	: 0.00 / 0.00 psi.g	Temperature, max	: 68.00 deg F
NPSH available, rated	: Ample	Fluid density, rated / max	: 0.998 / 0.998 SG
Frequency	: 60 Hz	Viscosity, rated	: 1.00 cP
		-	:

Performance		Material	
Speed, rated	: 1,755 rpm	Material requested	: Standard
Speed, maximum	: 1,800 rpm	Material selected	: Standard
Speed, minimum	: 850 rpm	**Pressure Data**	
Efficiency	: 77.68 %	Maximum working pressure	: 30.95 psi.g
NPSH required / margin required	: N/A / 0.00	Maximum allowable working pressure	: 95.00 psi.g
Ns (imp. eye flow) / Nss (imp. eye flow)	: N/A US Units	Maximum allowable suction pressure	: N/A
MCSF	: 819 USgpm	Hydrostatic test pressure	: N/A
Head maximum, rated speed	: 148 ft	**Driver & Power Data**	
Head rise to shutoff	: 107.37 %	Driver sizing specification	: Rated power
Flow, best eff. point (BEP)	: 1,947 USgpm	Margin over specification	: 0.00 %
Flow ratio (rated / BEP)	: 85.78 %	Service factor	: 1.00
Speed ratio (rated / max)	: 97.50 %	Power, hydraulic	: 30.10 hp
Head ratio (rated speed / max speed)	: 92.87 %	Power, rated	: 38.75 hp
Cq/Ch/Ce [ANSI/HI 9.6.7-2004]	: 1.00 / 1.00 / 1.00	Power, maximum, rated speed	: 39.09 hp
Selection status	: Acceptable	Minimum recommended motor rating	: 40.00 hp / 29.83 kW



Construction Datasheet

Customer	: FLO-SYSTEMS INC.	Quote Number	: 67586
Project	:	Model / Size	: F6K-M Prerotation
Item number	: 001R-A	Stages	: 1
Service	: Raw Sewage	Pump speed	: 1755.0
Quantity of pumps	: 3.0	Date last saved	: 25 Nov 2008 1:17 PM

Construction

Nozzle	Size	Rating (ANSI)	Face	Pos'n
Suction	8 in	125 lbs	FF	Left
Discharge	6 in	125 lbs	FF	Right

Impeller Type	: Screw-Centrifugal
Impeller Design	: Non-Clog
Pump Orientation	: Immersible
Bearing Type (Rad/Thr)	: Ball/Ball
Bearing Lubrication	: Oil
Rotation (view from wet-end)	: -

Materials

Casing	: Cast Iron
Impeller	: Ductile Iron
Liner	: High Chrome (regulable)
Elastomer	: Buna Wet End O-rings
Shaft	: -
Sleeve	: -

Pump Support, Lifting System and Suction Bell

Pump Support	: Precast 800 basin / ductile iron fastout
Guideshoe Material	: Ductile Iron
Lifting System	: 30 foot cable
Suction Bell	: Galvanized
-	: -

Weights (Approx.)

Bareshaft pump	: 450.0 lb
Baseplate	: 300.0 lb
Driver	: 600.0 lb
Total weight	: 1,500.0 lb

Driver Information

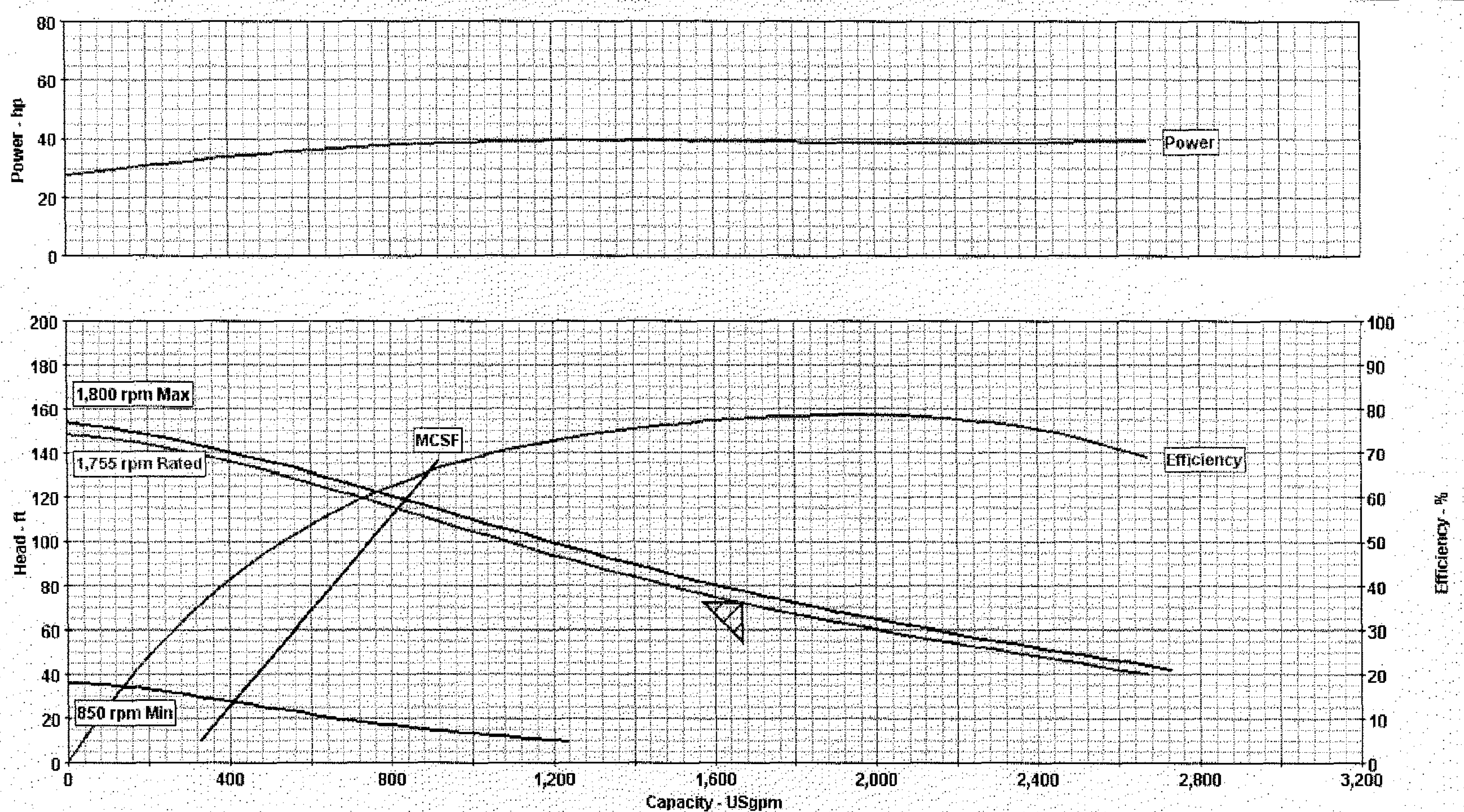
Manufacturer	: Hidrostal
Power	: 53.60 hp
Service factor	: -
Speed	: 1760
Orientation / Mounting	: N/A
Driver type	: Immersible
Frame-size	: -
Enclosure	: -
Hazardous area class	: -
Explosion rating	: -
Volts / Phase / Hz	: -
Insulation	: -
Temperature Rise	: -
Motor mounted by	: WSP

Seal, Gland and Piping

Seal Arrangement	: -
Seal Size	: -
Manufacturer	: -
Gland Material	: -
Seal Face Mat'l	: -
Throat Bushing	: N/A
Seal Flush Plan	: -
Seal Flush Construction	: -

Weir Specialty Pumps · 440 West 800 South · Salt Lake City, Utah 84101
phone: 801 359 8731 · fax: 801 355 9303 · www.weirsp.com

Pump Performance Curve



Customer	: FLO-SYSTEMS INC.	Pump size	: F6K-M	Flow, rated	: 1,670 USgpm
Customer reference	:	Stages	: 1	Head, rated	: 71.5 ft
Item number	: 001R-A	Pump speed, rated	: 1,755 rpm	Fluid density, rated / max	: 0.998 / 0.998 SG
Service	: Raw Sewage	Based on curve number	: P25-D110	Viscosity	: 1.00 cP
Quantity of pumps	: 3	Efficiency	: 77.68 %	Cq/Ch/Ce [ANSI/HI 9.6.7-2004]	: 1.00 / 1.00 / 1.00
Quote number	: 67586	Power, rated	: 38.75 hp	-	
Date last saved	: 25 Nov 2008 1:19 PM	NPSH required	: N/A	-	

General Arrangement Drawing

Customer	: FLO-SYSTEMS INC.	Quote number	: 67586
Customer reference	:	Pump size	: F6K-M Prerotation
Item number	: 001R-A	Stages	: 1
Service	: Raw Sewage	Pump speed	: 1755.0
Quantity of pumps	: 3.0	Date last saved	: 25 Nov 2008 1:17 PM

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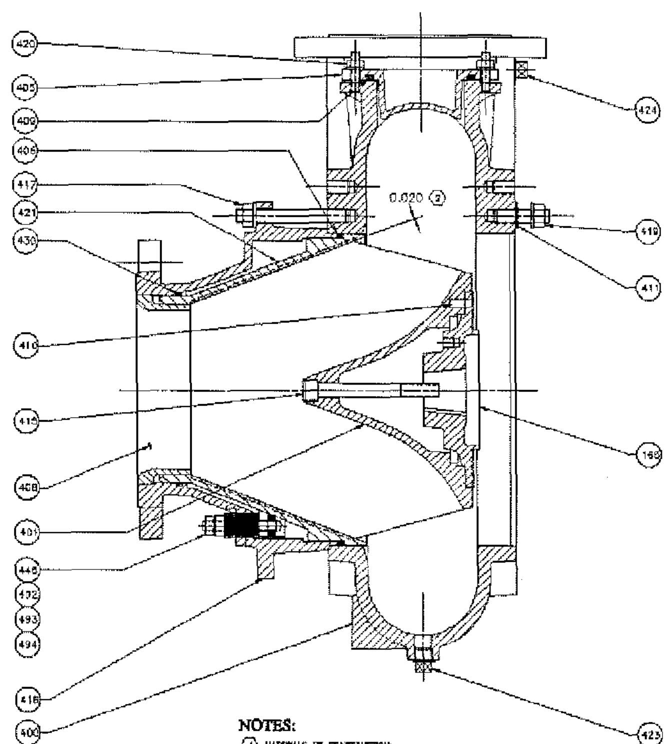
79386



ASSY L QTY	M QTY	H QTY	S QTY	ITEM NO.	PART NO.	DESCRIPTION	RAW PART NO.	MAT'L	UNIT WT.
1	1	1	1	166	71624-*	FLANGE, IMPELLER (F25/F2W BEARING FRAME)		(1)	
1	1	1	1		78413-*	FLANGE, IMPELLER (F45 BEARING FRAME)		(1)	
1	1	1	1	400	70014-*	CASING, VOLUTE		(1)	183
			1	401	70284-*	IMPELLER, FBK-S		(1)	54
		1			70079-*	IMPELLER, FBK-H		(1)	54
	1				70080-*	IMPELLER, FBK-M		(1)	54
1					70078-*	IMPELLER, FBK-L		(1)	54
1	1	1	1	405	70438-*	COVER, HANDHOLE		(1)	6
1	1	1	1	406	142336	O-RING, 7.0 X 346mm		BUNA-N	
1	1	1	1	408	70414-*	RING, WEAR		(1)	
1	1	1	1	409	142339	O-RING, 7.0 X 113mm		BUNA-N	
1	1	1	1	410	178034	PIN, DOWELL 8mm X 16mm		STL	
1	1	1	1	411	71890-2	SHIM KIT		STL	
		1	1	415	414566	BOLT, IMPELLER M16 X 130mm		316 SST	
1	1				414524	BOLT, IMPELLER M16 X 100mm		316 SST	
		1	1	416	70059-*	CASING, SUCTION		(1)	
1	1				70288-*	CASING, SUCTION		(1)	
		8	8	417A	421510	STUD, TAP END M16 X 100mm	(3)	STL	
		8	8		421841	STUD, TAP END M16 X 100mm	(3)	316 SST	
8	8				421701	STUD, TAP END M16 X 40mm	(3)	STL	
8	8				421702	STUD, TAP END M16 X 40mm	(3)	316 SST	
8	8	8	8	417B	40829	NUT, HEX M16 X 2.0	(3)	STL	
8	8	8	8		44133	NUT, HEX M16 X 2.0	(3)	316 SST	
8	8	8	8	417C	233025	WASHER, PLAIN 5/8	(3)	STL	
8	8	8	8		233030	WASHER, PLAIN 5/8	(3)	316 SST	
8	8	8	8	419A	421701	STUD, TAP END M16 X 40mm	(3)	STL	
8	8	8	8		421702	STUD, TAP END M16 X 40mm	(3)	316 SST	
8	8	8	8	419B	40829	NUT, HEX M16 X 2.0	(3)	STL	
8	8	8	8		44133	NUT, HEX M16 X 2.0	(3)	316 SST	
8	8	8	8	419C	233025	WASHER, PLAIN 5/8	(3)	STL	
8	8	8	8		233030	WASHER, PLAIN 5/8	(3)	316 SST	
2	2	2	2	420A	420941	STUD, TAP END M10 X 35mm	(3)	STL	
2	2	2	2		420942	STUD, TAP END M10 X 35mm	(3)	316 SST	
2	2	2	2	420B	44849	NUT, HEX M10 X 1.5	(3)	STL	
2	2	2	2		30670	NUT, HEX M10 X 1.5	(3)	316 SST	
2	2	2	2	420C	232535	WASHER, PLAIN 3/8	(3)	STL	
2	2	2	2		232520	WASHER, PLAIN 3/8	(3)	316 SST	
		1	1	421	70309-*	LINER		(4)	
1	1				70305-*	LINER		(4)	
1	1	1	1	423	232560	PLUG, AP SQ HD 1/2NPTM	(3)	STL	
1	1	1	1		242400	PLUG, AP SQ HD 1/2NPTM	(3)	316 SST	
1	1	1	1	424	232540	PLUG, AP SQ HD 1/2NPTM	(3)	STL	
1	1	1	1		242400	PLUG, AP SQ HD 1/2NPTM	(3)	316 SST	
1	1	1	1	430	142269	O-RING, 5.0 X 315mm		BUNA-N	
3	3	3	3	446	70450-4	NUT, REGULATOR		316 SST	
3	3	3	3	492	421261	STUD, TAP END M12 X 1.75 X 60		316 SST	
3	3	3	3	493	43879	NUT, HEX M12 X 1.75		316 SST	
3	3	3	3	494	20975	WASHER, LOCK M12		316 SST	

NOTES:

(1) MATERIALS OF CONSTRUCTION:
-1 = CAST IRON (FOR VOLUTE & SUCTION CASING ONLY)
-2 = 316 SST
-3 = CAST IRON (FOR IMPELLER ONLY)
-7 = HI-CHROME (FOR IMPELLER & LINER ONLY)

(2) SET IMPELLER CLEARANCE TO 0.020" MAXIMUM. CLEARANCE SHOULD BE CHECKED ALONG ENTIRE IMPELLER EDGE, AND AGAIN AFTER ROTATING IMPELLER 1/4, 1/2 AND 3/4 TURNS.

(3) FASTENER MATERIALS PER APPLICATION.

(4) MATERIAL AND MACHINING PER APPLICATION.

REV	DESCRIPTION	ECN	DATE	BY	CHKD	APPD	RELSD	NXT ASSY
1	ITEM 406 P/N 142336 WAS 142387	52454		JCH	BRD			

DIMENSIONS ARE IN INCHES
TOLERANCE:
.XX ± .03
.XXX ± .010
FRACTIONS ± 1/16
ANGLE ± 1°

WEMCO PUMP — SALT LAKE CITY, UTAH U.S.A.

WET END ASSEMBLY
F6K
REGULABLE
WEMCO-HIDROSTAL PUMPS

SCALE 1/2
SIZE D
DWG NO. 79386

General Arrangement Drawing

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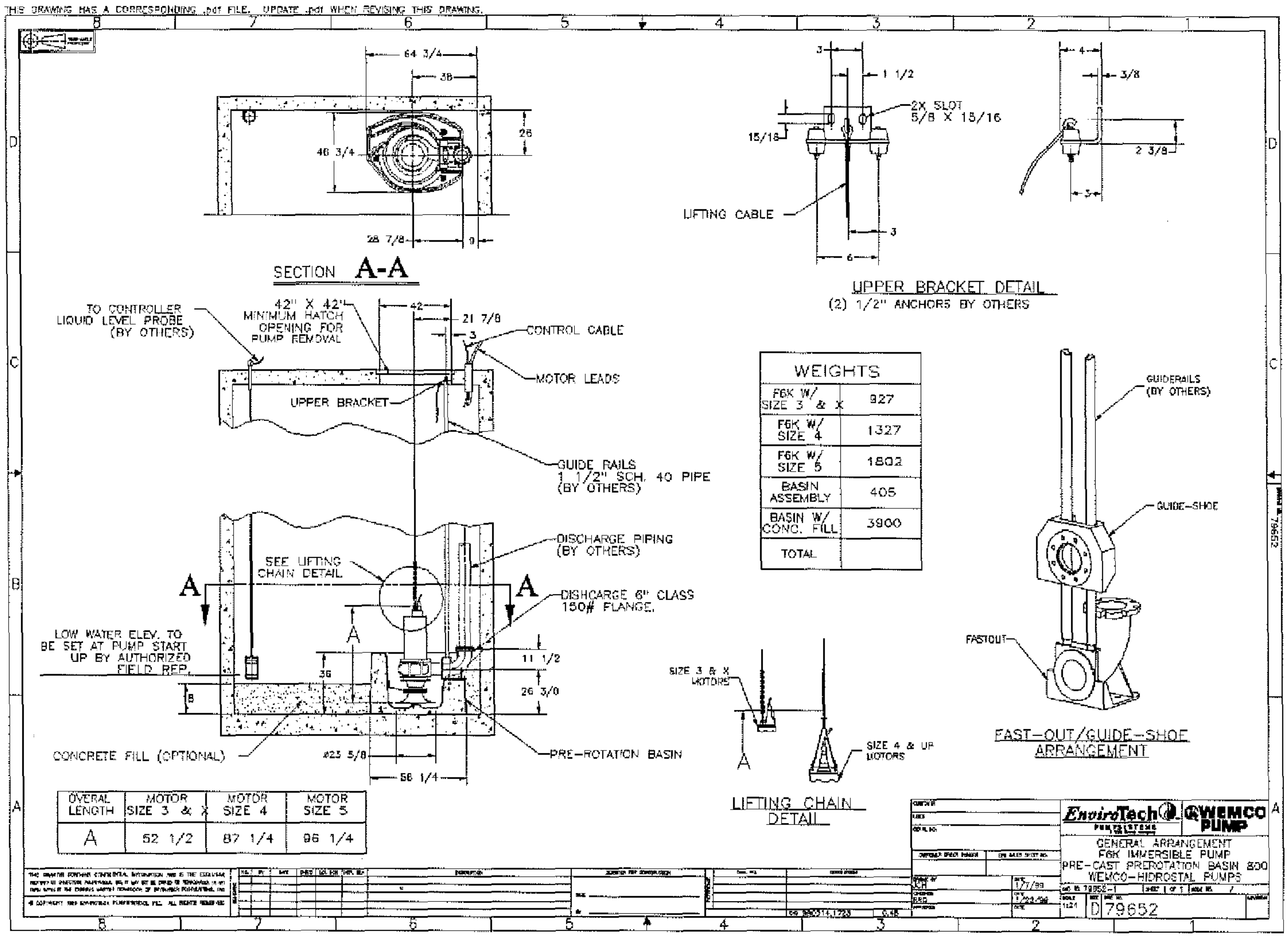
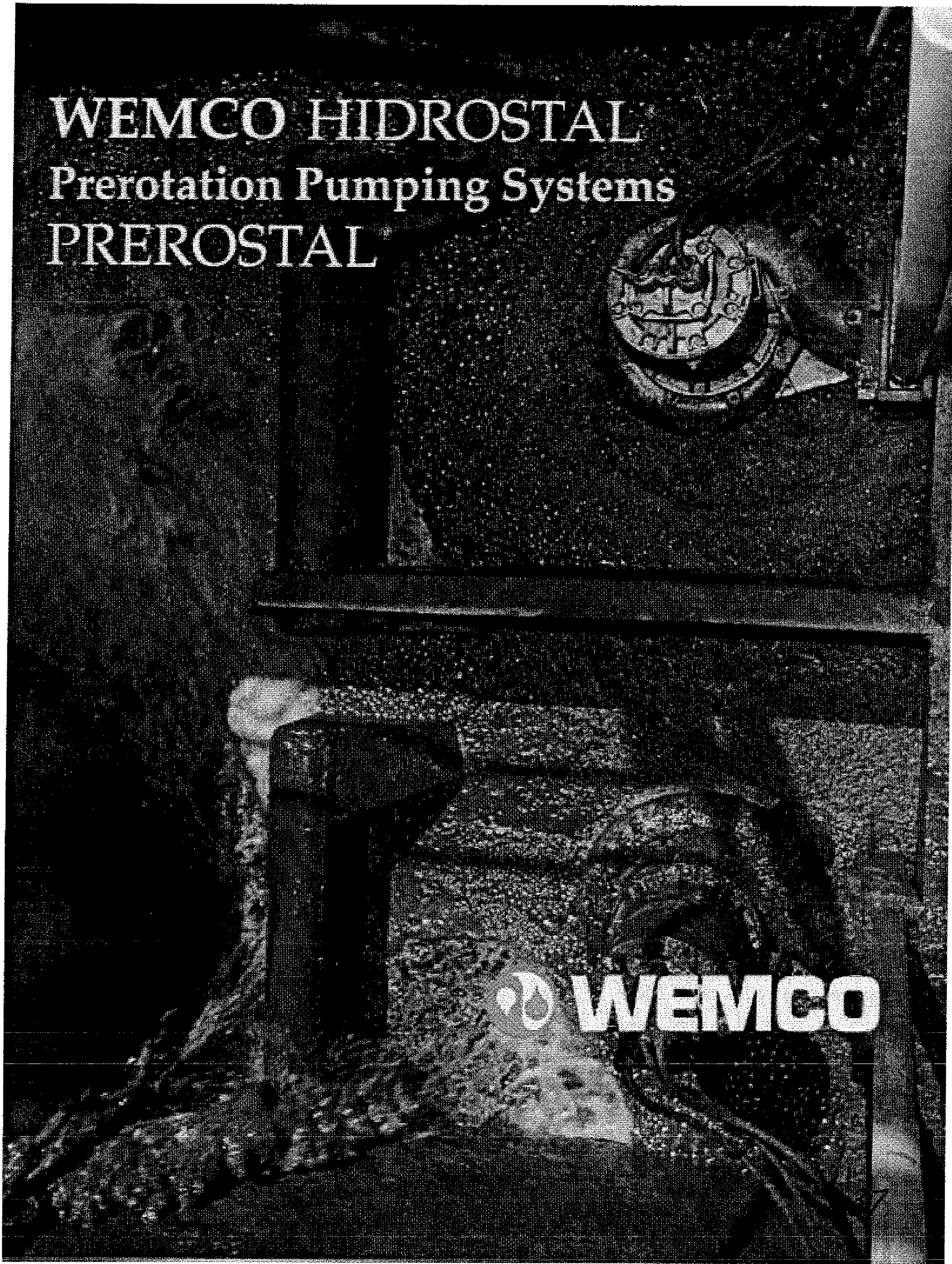


WEIGHTS	
F6K W/ SIZE 3 & X	927
F6K W/ SIZE 4	1327
F6K W/ SIZE 5	1802
BASIN ASSEMBLY	405
BASIN W/ CONC. FILL	3900
TOTAL	

OVERAL LENGTH	MOTOR SIZE 3 & X	MOTOR SIZE 4	MOTOR SIZE 5
A	52 1/2	87 1/4	96 1/4

APPENDIX C

WEMCO HYDROSTAL PUMP
PREROTATION MANUFACTURER BULLETION


WEMCO HIDROSTAL
Prerotation Pumping Systems
PREROSTAL
WEMCO

WEMCO® HIDROSTAL® PREROSTAL Prerotation Pumping Systems

Prerotation — The simple and economical solution to handling variable flow applications with large or troublesome solids.

Why Variable Flow Pumping?

Applications which have a large daily, or other periodic variation in flow rates (Figure 1), such as in

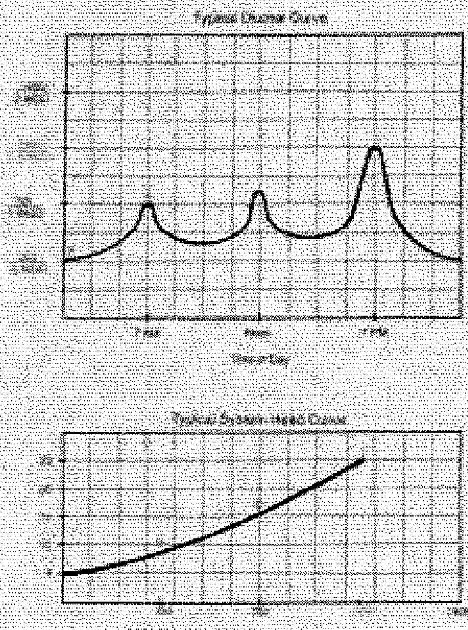


Figure 1

waste or storm water collection systems, are a challenging pump station design problem. The large swings in flow rates can make it difficult to optimize either the use of a single pump or even a number of pumps. When additional factors such as solids handling, electrical efficiency, system reliability, maintenance, and capital cost are added to the evaluation, the task becomes even more complex.

The pumping systems in use today to handle these challenges include variable speed centrifugal pumps (Figure 2), Archimedes spiral pumps, and multiple pumps staged in "on-off" sequences.

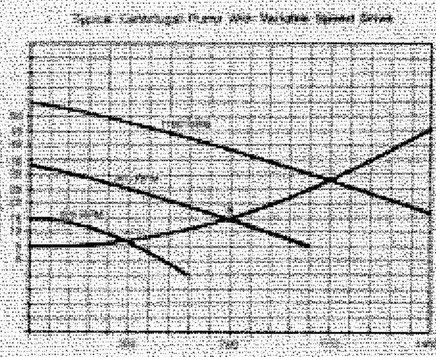


Figure 2

Each of these alternatives offer advantages, and may be the "right" solution under some circumstances.

For many applications, however, the flow matching benefits of these systems can be obtained by utilizing the WEMCO Prerostal pumping system, using only constant speed motors.

This system is the perfect answer to volume control while handling liquids with large amounts of troublesome solids, such as raw sewage, rags, storm water, and biological or other sludges. The Prerostal system is usually a more effective and economical method of adjusting pumping volume to varying inflow rates than the other alternatives mentioned; centrifugal pumps with expensive variable speed controls, multiple pumps with on-off level controls, or Archimedes spiral pumps.

A single pump can provide variations in flow from 100% of design capacity down to as low as 35% (Figure 3) and achieve this variation **using only constant speed motors.** No other system offers the simplicity and reliability of the WEMCO Prerostal system.

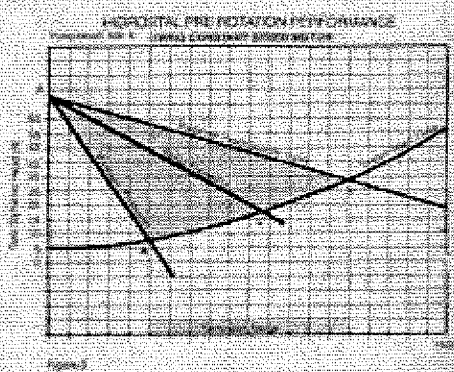


Figure 3

Why Prerotation Works

Prerotation is a well known physical phenomenon that occurs in centrifugal compressors and pumps. This natural prerotation is *designed out* of conventional centrifugal machines by anti-rotation vanes located in their suctions (Figure 4). These vanes "straighten" the flow prior to entry into the impeller and thus maintain the fluid entrance angles as originally designed into the equipment. This maintains the proper geometry between the impeller and its inflow, and thus achieves the intended performance of the device.

On the other hand, by using adjustable inlet guide vanes, prerotation can be *taken advantage* of in some applications to change the pump or compressor performance characteristics by actually inducing prerotation of the gas or liquid prior to entering the machine. This induced rotation in the suction of the machine changes the entrance angle from the original design, thus altering the performance of the machine. By controlling the degree of prerotation, the output and/or pressure can be varied while keeping the speed constant and efficiency high.

This is the common mechanism by which the adjustable guide vanes in the suction of centrifugal compressors operate (Figure 4a), as well as similar type guide vanes used on some larger water pumps and turbines.

Prerotation, using adjustable guide vanes, has been a recognized means of control for many years. It has not been taken advantage of in solids handling applications, however, because adjustable vanes would become immediately and hopelessly clogged in a flowstream containing rags (Figure 4b), and is therefore useless in this application.

The WEMCO Hidrostal Alternative: Prerostal

WEMCO-Prerostal overcomes clogging problems by using a large-clearance prerotation basin (Figure 5), to induce rotation to the pump. This enables the system to take advantage of prerotation's potential for pump performance modification, without the necessity of changing the pump speed, while still pumping rags and other large troublesome solids.

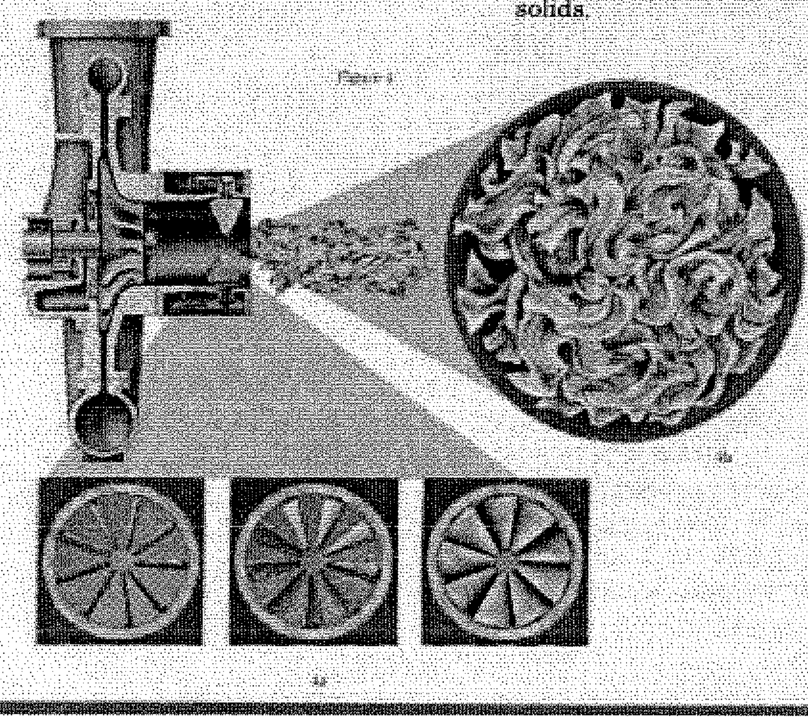


Figure 4

4b

4a

In operation, the rotation of the liquid in the prerotation basin causes the liquid to enter the impeller at an angle that is different from the angle used in the design of the pump. This change in approach angle from the design angle alters the pump hydraulic performance, resulting in a lower head/capacity curve and reduced energy consumption. The higher the velocity in the prerotating basin, the greater the decrease in capacity from the original condition.

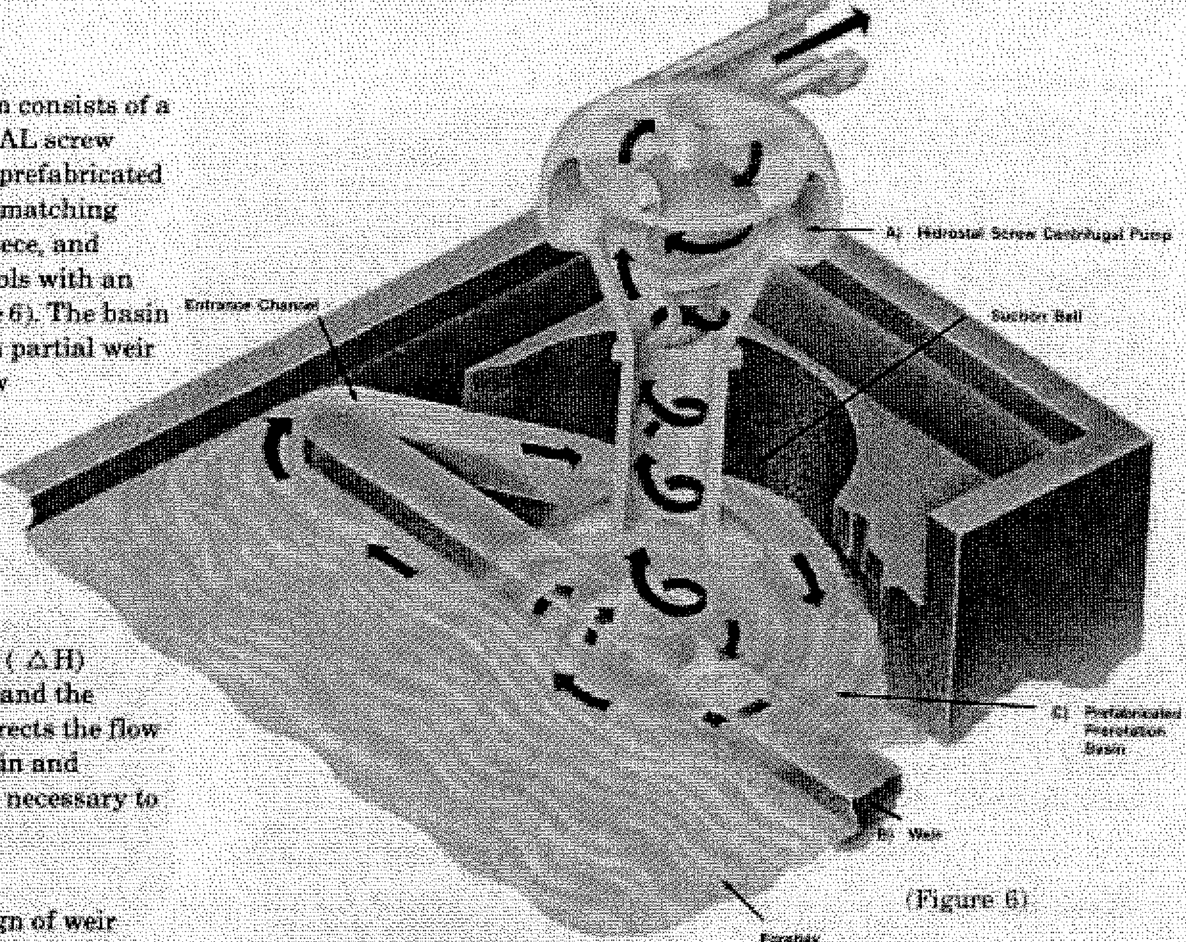
Figure 5

The prerotation effect creates a family of new head/capacity curves which will now intersect the system head curve at lower flows (Figure 3). The net effect means the discharge flow *automatically* matches the influent flow rate **without having to change the pump speed.** The result —**automatic flow matching** — is done using infallible gravity as the control mechanism, versus complex variable speed pumping systems or expensive spiral screw pumps.

No system could be simpler or more reliable.

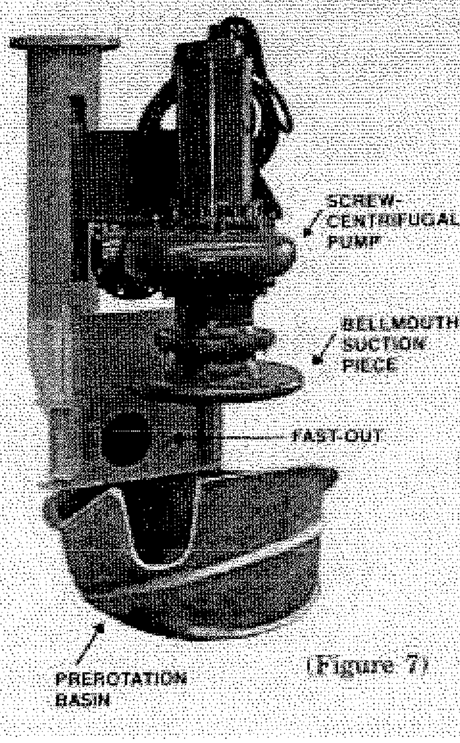
The WEMCO Prerotation Difference

The Prerostal system consists of a WEMCO-HIDROSTAL screw centrifugal pump, a prefabricated prerotation basin, a matching bellmouth suction piece, and standard level controls with an on-off switch (Figure 6). The basin is constructed with a partial weir in front to direct flow to the integral entrance channel . The inclined tangential entrance channel which regulates the elevation differences ($\triangle$H) between the forebay and the prerotation basin, directs the flow of liquid into the basin and provides the velocity necessary to induce prerotation.



(Figure 6)

With the proper design of weir height, entrance channel width, basin and bellmouth geometry, automatic matching of discharge flow rate to the influent flow rate can be established while **keeping the pump speed constant.**



(Figure 7)

Prerostal System Components

A. A standard Hidrostal pump with its unique impeller design combining the characteristics of centrifugal and positive displacement pumps.

B. A weir which incorporates an entrance channel is placed in front of a special basin and regulates the liquid flow to the basin.

C. A special basin which causes the liquid entering the pump suction to be rotated in the same direction as the pump impeller prior to its entry into the pump.