FINAL

WALNUT AND ANGUS STORMWATER PUMPING STATIONS PRELIMINARY DESIGN REPORT

Prepared for

County of San Mateo, Redwood City, California

April 26. 2012

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BROWN AND CALDWELL

201 North Civic Drive

Walnut Creek, California, 94596

201 North Civic Drive, Suite 115
Walnut Creek, California 94596
Tel: 925-937-9010
Fax: 925-937-9026
www.brownandcaldwell.com

April 26, 2012

Mr. Mark Chow, P.E.
Project Manager
Principal Civil Engineer
Utilities-Flood Control-Watershed Protection
Department of Public Works
County of San Mateo
555 County Center, 5th Floor
Redwood City, California 94063-1665 11/138101-001.5

Subject: Final Walnut and Angus Stormwater Pumping Station
Preliminary Design Report

Dear Mr. Chow:

Brown and Caldwell (BC) is pleased to submit this Final Preliminary Design Report (PDR) for the Walnut and Angus Stormwater Pumping Stations. This PDR evaluates rehabilitation of the existing stormwater pumping stations versus new pumping stations.

BC completed a hydraulic analysis for both pumping stations. Additionally, BC conducted site visits of both pumping stations to perform mechanical, structural, electrical, and instrumentation inspections. Based on the results of the hydraulic analysis and inspections, a list of project elements for rehabilitating the existing pumping stations was developed. An estimated construction cost for each of the elements was also developed. The estimated construction cost for rehabilitation of the Walnut Stormwater Pumping Station is $940,000, while the estimated construction cost for rehabilitation of the Angus Stormwater Pumping Station is $1,425,000. For comparison purposes, the construction cost for new stormwater pumping stations was developed based on cost curves. The estimated construction cost for a new stormwater pumping station at Walnut is $4,000,000 to $6,000,000, while the estimated construction cost for a new stormwater pumping station at Angus is $3,000,000 to $5,000,000. BC recommends that the existing stormwater pumping stations be rehabilitated rather than replaced.

It has been an enjoyable experience working with you and County and City of San Bruno staff on this project. Please contact me at 925.210.2432 if you have any questions or require additional information.

Very truly yours,

Brown and Caldwell

Timothy R. Banyai, PE
Project Manager

TB:ddt

cc: File

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LIST OF ACRONYMS

ABB	Asea-Brown Boveri
AFD	Adjustable frequency drives
ANSI/HI	American National Standards Institute/Hydraulic Institute
ASCE	American Society of Civil Engineers
ASCO	Automatic Switch Company
ASME	American Society of Mechanical Engineers
ATS	automatic transfer switch
BC	Brown and Caldwell
BEP	best efficiency point
CEC	California Electric Code
cfm	cubic feet per minute
cfs	cubic feet per second
C-H	Cutler-Hammer
ENR CCI	Engineering News Record Construction Cost Index
fps	feet per second
gpm	gallons per minute
hp	horsepower
HVAC	Heating/Ventilation/Air Conditioning
MCB	main circuit breaker
MCC	motor control center
$NPSH_A$	net positive suction head available
$NPSH_R$	net positive suction head requirements
PDR	Preliminary Design Report
PE	Professional Engineer
PG&E	Pacific Gas & Electric Company
POR	preferred operating range
psi	pounds per square inch
rpm	revolutions per minute
WSEL	well water surface elevations

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EXECUTIVE SUMMARY

The purpose of this Preliminary Design Report (PDR) is to evaluate the existing Walnut and Angus Stormwater Pumping Stations. The evaluation includes a hydraulic analysis and pumping station assessment of the structural, mechanical, electrical, and instrumentation components. Based on the evaluation and assessment, modifications to rehabilitate the pumping stations to current industry standards are developed. Replacement of the pumping stations for use as a comparison to rehabilitated pumping stations is also considered in this report.

The Walnut and Angus Stormwater Pumping Stations were constructed in the late 1960s. For the most part, the pumping stations have not been modified from the original construction.

The original Walnut Stormwater Pumping Station constructed in 1968 consisted of three single stage, constant speed vertical propeller pumps. Each pump was rated for 5,500 gallons per minute (gpm) at 16.5 feet total head at a maximum rotational speed of 1,175 revolutions per minute (rpm). The pumps were Johnston Model 14 PO type pumps provided with 25 horsepower (hp) electric motors. In 1997, Pump 2 was replaced with a larger pump and a new fourth pump (Pump 4) identical to Pump 2 was installed. The two larger pumps are rated at 14,000 gpm, at 14 feet total head. These pumps are Johnston Model 20 PO type pumps with 75 hp electric motors. Also in 1997, Pump 1 was rebuilt and refitted with a new 30 hp electric motor. All four pumps were provided with adjustable speed drives as part of the 1997 upgrade.

The Angus Stormwater Pumping Station was also constructed in 1968. The pumping station contains two single stages, two speed vertical propeller pumps. The two pumps are Johnston Model 30 PO type pumps. Each pump is rated for 30,000 gpm at 13.5 feet total head. Each pump is fitted with a Johnston Model HG-250 vertical hollow shaft gear drive having a 3 to 1 speed ratio. Each pump is driven by a propane fueled engine having a continuous rating of 110 hp and a maximum speed of 1,755 rpm.

Brown and Caldwell (BC) performed a hydraulic analysis of both pumping stations and conducted site visits of both pumping stations to perform mechanical, structural, electrical, and instrumentation inspections. Based on the results of the analyses and site inspections, a list of project elements for rehabilitating the existing pumping stations was developed.

Based on the results of the hydraulic analysis and site visit, recommended rehabilitation project elements of the Walnut Stormwater Pumping Station consist of the following:

- Coat the 16-inch diameter discharge piping and flap gates.
- Replace the existing grating used for capturing debris with an automated mechanically cleaned bar screen.
- Repair roof.
- Provide thermostatically controlled supply fan rated at six to ten air exchanges per hour for positive ventilation. Provide particulate air filters on intake louvers to minimize dust infiltration.
- Install a second ground rod to meet current electrical codes.
- Replace existing generator and controls with a new 150 kW unit.
- Replace Adjustable frequency drives (AFDs) or convert existing pumps to constant speed pumps.

- Replace main pump controller.
- Rehabilitate miscellaneous electrical components to meet current electrical code requirements. See Section 2.8.11 for complete list.

Based on the results of the hydraulic analysis and site visit, recommended rehabilitation project elements of the Angus Stormwater Pumping Station consist of the following:

- Repair concrete encasement on 36-inch discharge piping.
- Replace the existing grating used for capturing debris with an automated mechanically cleaned bar screen.
- Replace roof hatches.
- Provide supply fan rated at six to ten air exchanges per hour for positive ventilation. Provide particulate air filters on intake louvers to minimize dust infiltration.
- Recommend inspection of the propane system by a firm that specializes in certification of tanks rated for American Society of Mechanical Engineers (ASME) applications.
- Remove existing pump engines and right angle gear drives. Replace with new electrical vertical motors to drive the existing pumps.
- Install new standby generator.
- Install new ground rods to meet current electrical codes.
- Replace main pump controller.
- Replace event recorder.
- Replace site lighting.
- Rehabilitate miscellaneous electrical components to meet current electrical code requirements. See section 3.8.10 for complete list.

Wet well and pump modifications are not recommended for Walnut or Angus Stormwater Pumping Stations.

An estimated construction cost for each of the pumping stations was also developed. The estimated construction cost for rehabilitation of the Walnut Stormwater Pumping Station is $940,000, while the estimated construction cost for rehabilitation of the Angus Stormwater Pumping Station is $1,425,000. For comparison purposes, the construction cost for new stormwater pumping stations was developed based on cost curves. The estimated construction cost for a new stormwater pumping station at Walnut is $4,000,000 to $6,000,000, while the estimated construction cost for a new stormwater pumping station at Angus is $3,000,000 to $5,000,000.

BC recommends that the existing stormwater pumping stations be rehabilitated rather than replaced.

1. INTRODUCTION

This report serves as the Preliminary Design Report (PDR) for the Walnut and Angus Stormwater Pumping Stations. The Walnut and Angus Stormwater Pumping Stations are owned by the County of San Mateo and operated by the City of San Bruno.

This PDR represents the project deliverable for Task Order No. 1 for the As Needed Engineering Contract between the County of San Mateo and Brown and Caldwell (BC). This PDR is organized as follows:

- Executive Summary
- Chapter 1 – Introduction
- Chapter 2 – Walnut Stormwater Pumping Station Evaluation
- Chapter 3 – Angus Stormwater Pumping Station Evaluation
- Chapter 4 – Alternatives and Construction Cost development
- Chapter 5 - Recommendations

This chapter discusses the purpose of the PDR, scope of work included within Task Order No. 1, and provides a summary of the background information reviewed for the report.

1.1 Purpose

The purpose of this PDR is to evaluate the existing Walnut and Angus Stormwater Pumping Stations. The evaluation includes a hydraulic analysis and pumping station assessment of the structural, mechanical, electrical, and instrumentation components. Based on the evaluation and assessment, modifications to rehabilitate the pumping stations to current industry standards are developed. Replacement of the pumping stations for use as a comparison to rehabilitated pumping stations is also considered in this report.

1.2 Scope of Work

The scope of work for the PDR consists of the following elements. A discussion of each scope of work element is provided in the following sub sections.

1.2.1 Documentation

- Review the existing maintenance records, station flow records, as-built drawings, design specifications, pump performance curves, and past reports, for each pumping station.
- Based on the review of the available information, develop operational and performance requirements for each pumping station.
- Conduct a site inspection with staff from County of San Mateo and City of San Bruno. Discuss historical operational and maintenance problems at each pumping station, remedial corrective action implemented to date, and obtain input as to staff concerns.
- Inspect each pumping station to examine its operation and assess the effectiveness of the existing pumping equipment, structural facilities, electrical power and control equipment, screening and debris removal, and ventilation facilities.

- Document facility deficiencies.

1.2.2 Hydraulic Analysis

- Complete hydraulic analysis of each pumping station based on record drawings and design specifications.
- Confirm and update actual pumping operational conditions and performance requirements for each pumping station based on information provided by the County of San Mateo.
- Develop stormwater flow calculations based on available existing data for the area.

1.2.3 Pumping Station Assessment

- Evaluate and develop specific improvements to pumping system equipment, forebay, screening and debris removal, electrical power and control system, natural gas piping system, ventilation, and building to correct or up-grade identified deficiencies.
- Complete code compliant assessment for electrical, mechanical and structural pumping station components.
- Complete an American Society of Civil Engineers (ASCE) Tier 1 structural analysis on each building.

1.2.4 Alternatives Development

- Rehabilitate existing pumping stations to resolve identified issues and meet current applicable standards and codes.
- Complete facility replacement of each pumping station including provision of a new structural building, land acquisition, new pumping and associated mechanical equipment, ventilation (Heating/Ventilation/Air Conditioning [HVAC]) system, new electrical power and control system, and instrumentation monitoring and control equipment.

1.2.5 Estimated Construction Cost

- Develop a preliminary construction cost analysis for comparison of the two alternatives for each pumping station.
- Identify environmental constraints at each of the pumping stations (construction cost for the identified environmental constraints are not to be developed).

1.2.6 Preliminary Design Report Preparation

- Prepare a draft report presenting the findings, conclusions, and recommendations that identify possible modifications to the pumping equipment and the pumping stations as appropriate to correct problems or complete pumping station facility replacement.
- Meet with the County of San Mateo and the City of San Bruno staff to present the Preliminary Design Report. Prepare agenda and meeting minutes for review meeting.
- Prepare final report addressing comments received on the draft report. The final report will serve as the design basis for the recommended facilities.

1.3 Background Information

Existing documentation for the Walnut and Angus Stormwater Pumping Stations provided for our review are summarized below. Background information reviewed consisted of four studies, two sets of as-built drawings, and miscellaneous information including pump equipment manufacturer catalog data, installation drawings, and pumping curves.

1.3.1 San Bruno Creek Flood Control Zone

Results of a preliminary engineering study of the San Bruno Creek Watershed was published in August 1965, in the report titled San Bruno Creek Flood Control Zone by Wilson, Ham, and Blair. The report provided the San Mateo County Flood Control District with a preliminary plan and cost data for correcting drainage deficiencies existing within San Bruno Creek and its major tributaries. Report recommendations consisted of a comprehensive drainage project to upgrade the watershed including major channel improvements, a maintenance program, and drainage of isolated low areas. The project's goal was to eliminate flooding while accommodating a 25-year design flood.

1.3.2 Drawings and Specifications, April 1968

Drawings and specifications were prepared in April 1968 by Wilsey and Ham for construction of stormwater pumping facilities. The project included work for existing Pump Station No. 1 (Belle Air Station), which is currently identified as Walnut Stormwater Pumping Station. The main design element for this pumping station was three constant speed 25 horsepower (hp) pumps.

1.3.3 Storm Drain Master Plan Study Analyses for the City of San Bruno (1991)

A final report of conceptual plans for drainage improvements prepared for the City of San Bruno was completed in July, 1991. The report titled Storm Drain Master Plan Study for the City of San Bruno was prepared by Bissel and Karn. The report included an analysis of the existing mainline storm drain system, criteria and methodology of the analysis, identification of problem areas, and improvement alternatives to reduce flooding frequency and magnitude. Included in the report was a 25-year design flow projection for the Walnut Stormwater Pumping Station.

1.3.4 Pumping Station Upgrade (1997)

Pumping station improvements to the Walnut Stormwater Pumping Station were prepared in 1997 by Brian Kangas Foulk. The purpose of the project was to increase the pumping capacity. A new, larger pump was added to the station, an existing pump was replaced with a larger pump, and all four pumps were provided with variable frequency drives.

1.3.5 Update to the Storm Drain Master Plan Study Analyses for the City of San Bruno (2001)

The 1991 Master Plan analyses was updated in April, 2000. The report titled Update of City of San Bruno Storm Drainage Master Plan Analyses for the City of San Bruno was prepared by Brian Kangas Foulk. The update revised analysis methodology for future storm drain system analyses and identified that a portion of the Jenevein Storm Drain system did not provide a design 25-year storm level of flood protection.

1.3.6 Walnut Storm Water Pumping Station (2006)

In June, 2006, an evaluation of the Walnut Storm Water Pumping Station was prepared by Bonneau Dickson, Professional Engineer (PE). The evaluation purpose was to address City of San Bruno concerns regarding the high level of operating and maintenance effort required for the pumping station, the condition of the existing facility, and the actual pumping capacity required. Based on the evaluation, debris plugging of the screen ahead of the pump wet well was identified as the main cause of diminished capacity and excessive operating and maintenance effort.

1.3.7 Miscellaneous Information

Pump equipment manufacturer catalog data, installation drawings, and pumping curve information for the existing pumps were furnished and reviewed.

2. WALNUT STORMWATER PUMPING STATION EVALUATION

This chapter discusses the Walnut Stormwater Pumping Station evaluation. This chapter is divided into eight sections including documentation review; hydraulic analysis; pumping assessment; wet well and screening and debris removal; structural assessment; ventilation; natural gas system, and electrical power and control system.

2.1 Documentation Review

Results of our examination of existing documents and records for the Walnut Stormwater Pumping Station are summarized in this section.

2.1.1 Wet Well

Flow enters the pumping station from the south in a 42-inch-diameter storm drain that discharges into a short entrance channel. Flow passes through a trash rack and then into partitioned sections of the wet well that are dedicated for each pump suction. Originally there were three sections. In 1997, a fourth wet well section was added and a three foot by three foot bar screen was installed in the east wall separating the wet well from the entrance channel ahead of the trash rack.

The partitions in the wet well do not meet the American National Standards Institute/Hydraulic Institute (ANSI/HI) standards for pump intake design. Because the wet well does not meet these standards, rotating flow, and thus, poor hydraulic pump intake conditions may exist. With poor hydraulic and inlet conditions, pump performance may be adversely affected. The following list of phenomena may occur in the wet well from the poor hydraulic and pump intake conditions: 1) free-surface vortices, 2) submerged vortices, 3) excessive pre-swirl of flow entering the pump, 4) non-uniform spatial distribution of velocity at the impeller eye, 5) excessive variations in velocity and swirl with time in the suction piping, and 6) entrained air or gas bubbles (ANSI/Hydraulic Institute, 1998). Typical symptoms of poor hydraulic conditions within a wet well are reduced flow rate, reduced head, effects on power, and increased vibration and noise.

At this time, it is not recommended that any wet well modification be considered. County and City staff have not indicated any pumping issues related to capacity. It can be very costly to make wet well changes.

2.1.2 Pumping Equipment

In 1968, three single stage, constant speed vertical propeller pumps were installed in the pumping station. Each pump was rated for 5,500 gallons per minute (gpm) at 16.5 feet total head at a maximum rotational speed of 1175 revolutions per minute (rpm). The pumps were Johnston Model 14 PO type pumps provided with 25 hp electric motors.

In 1997, Pump 2 was replaced with a larger pump and a new fourth pump (Pump 4) identical to Pump 2 was installed. Figure 2-1 shows Pump 2. The two new pumps are rated 14,000 gpm at 14 feet total head at 880 rpm. These pumps are Johnston Model 20 PO type pumps with 75 hp electric motors. At the same time, Pump 1 was rebuilt and refitted with a new 30 hp electric motor. Figure 2-2 shows Pump 1.

All four pumps were provided with adjustable speed drives as part of the 1997 upgrade.

The Walnut Stormwater Pumping Station also contains a small self priming wet well dewatering pump. Figure 2-3 shows this pump. Recommendations for modifications/improvements to the pumping equipment are provided in Section 2.2.

Figure 2-1. Walnut Stormwater Pumping Station: Pump 2 (75 hp).

Figure 2-2. Walnut Stormwater Pumping Station: Pump 1 (30 hp).

Figure 2-3. Walnut Stormwater Pumping Station: Wet Well Dewatering Pump.

2.1.3 Pump Discharge

For the pumps installed in 1968, pump discharge consisted of 16-inch-diameter cast iron mechanical joint pipe. The piping was routed from each pump eastward from the pumping station terminating in the North Channel. Each discharge pipe was provided with a 16-inch flap gate. As part of the 1997 modifications, new 24-inch-diameter discharge piping was installed for the new Pump 4 and the existing Pump 2 discharge pipe was replaced with a 24-inch diameter pipe. A 24-inch flap gate was also provided for Pump 2 and 4 discharge piping.

Figure 2-4 shows the discharge piping and flap gates. As can be seen from Figure 2-4, the pump discharge piping and flap gates are in good condition. The 16-inch diameter piping and flap gates are not coated. The 16-inch diameter piping and flap gates should be coated to extend the life of the piping.

Figure 2-4. Walnut Stormwater Pumping Station: 24-inch and 16-inch Discharge Pipes

2.1.4 Pumping Station Design Flow

Based on the 1991 Storm Drain Master Plan Study, the pumping station receives storm runoff from Watershed F. The watershed covers an area of approximately 60 acres and is shown in Figure 2-5. The area is bounded by the Southern Pacific Railroad, Walnut Street, Pine Street, and 7th Avenue. The calculated 25-year peak flow for this watershed is 45 cubic feet per second (cfs) or 20,200 gpm.

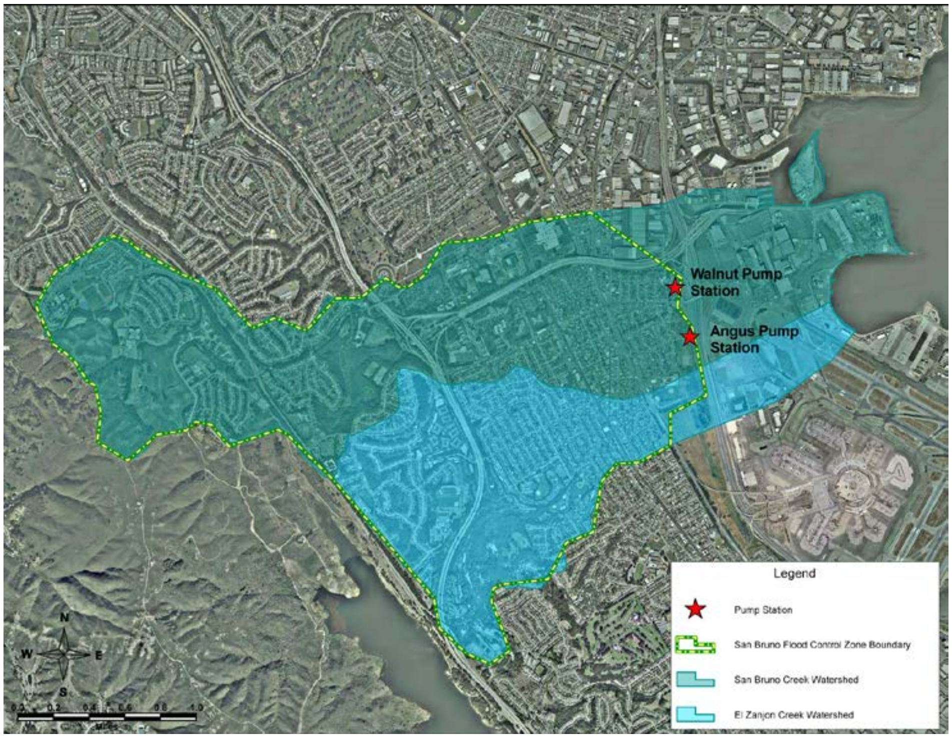

Figure 2-5. Walnut Stormwater Pumping Station Watershed Area

2.2 Hydraulic Analysis

The purpose of this section is to perform a hydraulic analysis on the existing Walnut Stormwater Pumping Station to determine if there is sufficient capacity to convey the 25-year stormwater flow. The pumping station constructed in 1967 and modified in 1997 consists of four vertical propeller pumps, each with an independent discharge.

2.2.1 Available Information

The following documents were reviewed and used to complete the hydraulic analysis:

- Pump 1 -Johnston Vertical Propeller Pump Model 14 PO Pump Curves Serial Number GA-3881-82, dated July 23, 1968. Refer to Appendix A for manufacturer pump curves.
- Pump 2 - Johnston Vertical Propeller Pump Model 14 PO Pump Curves Serial Number 97JT2694 A, dated February 1998. Refer to Appendix A for manufacturer pump curves.
- Pump 3 - Johnston Vertical Propeller Pump Model 14 PO Pump Curves Serial Number GA-3880, dated July 23, 1968. Refer to Appendix A for manufacturer pump curves.
- Pump 4 - Johnston Vertical Propeller Pump Model 14 PO Pump Curves Serial Number 97JT2694 B, dated February 1998. Refer to Appendix A for detailed manufacturer pump curves.
- San Bruno Creek Flood Control Project – Walnut Pumping Station Renovation Drawings dated July 1997 prepared by Brian Kangas Foulk. Refer to Appendix B for drawings.
- Walnut Pumping Station wet well operation levels and North channel water elevation and email correspondence dated September 30, 2009, from Anna Mui, County of San Mateo. Refer to Appendix C for email correspondence.

2.2.2 Hydraulic Capacity

A pump curve versus system curve analysis was developed to evaluate the potential operating scenarios for the pumping station. Manufacturer's information was used to develop the pump curve for each pump. A mathematical model based upon the Hazen-Williams formula to calculate pipe friction loss was used to develop the system curve. A low and high operating system curve was developed to determine the potential range of pump operating conditions. Hazen Williams friction factors (C) of 130 and 145 were used to develop the high and low operating conditions. The minor losses (i.e., pipe fitting losses and valves) were calculated by multiplying the velocity head by standard fitting headloss coefficients.

Wet well water surface elevations (WSEL) were provided by Anna Mui, County of San Mateo. Table 2-1 summarizes the static head conditions.

Table 2-1. Hydraulic Conditions

	Wet Well Water Surface (WSEL), feet		North Channel WSEL[1], feet	
	Pump On	Pump Off	Low	High
Walnut Stormwater Wet Well Low Operating Level - Pump 1	3.0	2.5	11.0	13.0
Walnut Stormwater Wet Well Low Operating Level - Pump 2	5.0	3.0	11.0	13.0
Walnut Stormwater Wet Well Low Operating Level - Pump 3	3.5	3.0	11.0	13.0
Walnut Stormwater Wet Well Low Operating Level - Pump 4	5.5	3.0	11.0	13.0

[1]Top of berm elevation of North Channel per the San Bruno Creek Flood Control Project – Pumping Station No. 1 Drawings dated April 1968 prepared by Wilsey and Hamm.

Each pump has its own dedicated discharge pipe and flap gate that conveys stormwater flow into the North Channel. Pumps 1 and 3 have a 16-inch discharge pipe, and Pumps 2 and 4 have a 24-inch discharge pipe. Each discharge pipe has a flap gate at the end to prevent canal flow intrusion into the Walnut Stormwater Pumping Station.

2.2.2.1 Small Pumps in Operation

Pump curve versus the system curves were developed for the following operating conditions:

- Small pump in operation.
- High North Channel WSEL.
- Low and high Walnut Stormwater Pumping Station wet well WSEL.
- Friction factor C of 130 and 145.

Figure 2-6 shows the pump curve versus the system curves for each of the potential operating conditions at the Walnut Stormwater Pumping Station for Pumps 1 and 3 in operation.

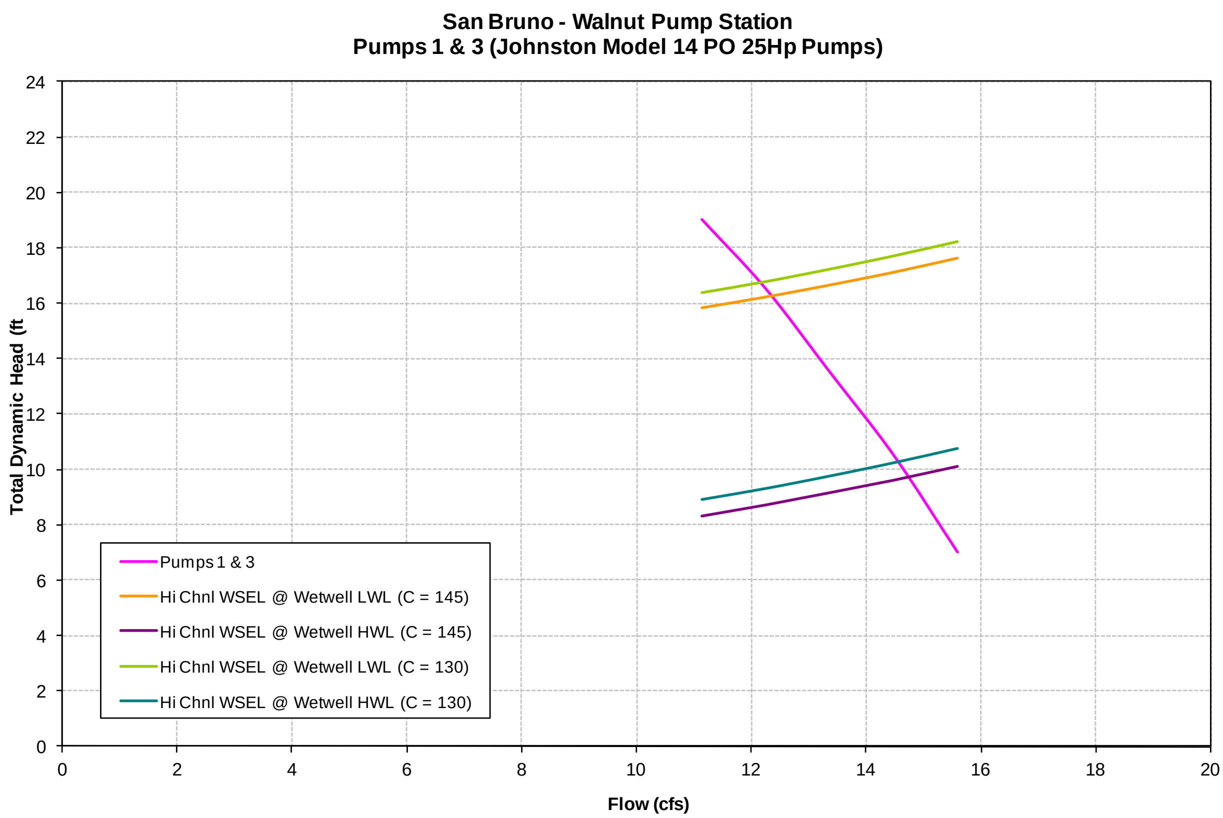

Figure 2-6. Walnut Stormwater Pumping Station: Small Pump in Operation at Friction Factor C of 130 and 145.

Based on the head capacity curves in Figure 2-6, each pump can convey approximately 12 to 15 cfs (5,400 to 6,700 gpm) per pump depending on the wet well and North Channel water surface elevations. The preferred operating range (POR), as defined by ANSI/HI, is between 9.8 to 14.1 cfs (4,400 to 6,300 gpm) based on the pump operating at its most efficient point of 12.3 cfs (5,500 gpm). If both Pumps 1 and 3 are operating at its most efficient point, approximately 24.5 cfs (11,000 gpm) of stormwater flow can be conveyed to the North Channel.

Evaluation of the bell suction velocity was also performed. Based on the existing Johnston Propeller Pump Model 1 Stage 14 PO drawings, the pump has a suction umbrella diameter of 36-inches. Assuming the pumps can convey a maximum flow of approximately 14.5 cfs (6,500 gpm) each, the corresponding bell entrance velocity is approximately 2.1 feet per second (fps). This velocity is well below the recommended Hydraulic Institute velocity of 5.5 fps. Since access to the pump wet well was not available during the site visit, confirmation of the existence of the suction umbrella cannot be validated. Assuming that the suction umbrella does not exist, the corresponding bell entrance velocity is approximately 4.8 fps which is still below the recommended Hydraulic Institute velocity of 5.5 fps.

Minimum submergence of the pump suction was also calculated. Sufficient submergence on the pump inlet can reduce the affect free surface vortices have on the pump performance. The following ANSI/HI equation was used to calculate the minimum submergence for the pump:

$$S = D + 0.574\left(\frac{Q}{D^{1.5}}\right)$$

where: S = minimum submergence, inches
D = diameter, inches
Q = flow, gpm

Assuming the pumps can convey a maximum flow of approximately 14.5 cfs (6,500 gpm) each, the corresponding minimum submergence is approximately 4.4 feet if the pump suction has a suction umbrella, and 4.7 feet if no suction umbrella is present. The wet well bottom elevation is -5.5 feet with a low wet well WSEL of -3.0 feet and a high wet well WSEL of 4.5 feet. The low wet well WSEL corresponds to a water depth of approximately 2.5 feet, and the high wet well WSEL corresponds to a water depth of approximately 10 feet. To maintain the ANSI/HI recommended calculated minimum submergence of 4.4 feet or 4.7 feet, the low wet well WSEL should be increased approximately 1.9 feet if a suction umbrella is present or 2.2 feet if the suction umbrella is not present.

The wet well level also affects the net positive suction head available ($NPSH_A$) for the pump, which affects pump operation and performance. As Figure 2-7 shows, the net positive suction head requirements ($NPSH_R$) increase quickly outside the best efficiency point (BEP). Damaging cavitation can occur under these operating conditions.

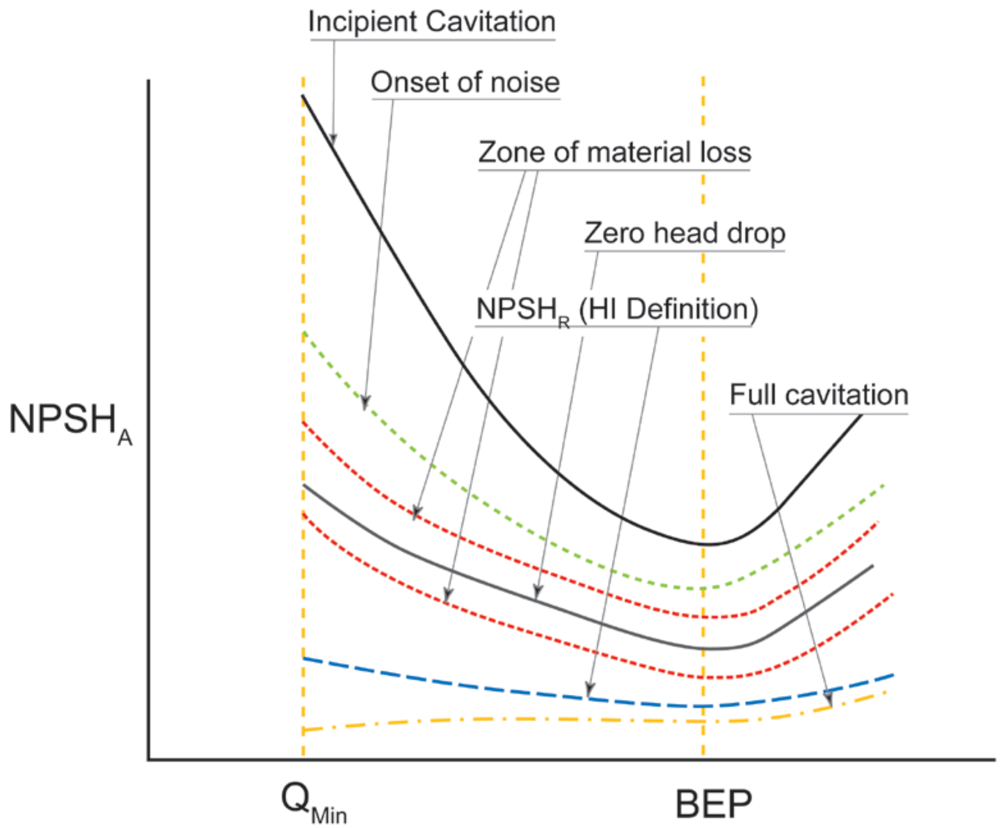

Figure 2-7. Net Positive Suction Head

$NPSH_A$ is calculated by the following formula:

$$NPSH_A = H_{bar} + h_s - H_{vap} - h_{fs} - \sum h_m - h_{vol} - FS$$

H_{bar} = Barometric pressure, feet

h_s = Static head, feet

H_{vap} = Vapor pressure, feet

h_{fs} = Pipe friction, feet

$\sum h_m$ = Minor pipe friction losses, feet

h_{vol} = Partial pressure, 2 feet for this application

FS = Factor of safety, 5 feet for this application with poor inlet conditions

The $NPSH_A$ for a maximum flow for one pump operating at 14.5 cfs (6,500 gpm) is approximately 31.6 feet. The $NPSH_R$ curve for the existing pumps is approximately 22 feet. As a minimum, for pumps operating within 85 percent and 115 percent of BEP capacity, BC and the ANSI/HI recommend that the minimum $NPSH_A/NPSH_R$ margin ratio be 1.3. For pumps operating outside this range, it is recommended the

$NPSH_A/NPSH_R$ margin ratio be increased to 1.8. The $NPSH_A/NPSH_R$ margin ratio is 1.4. Based on the information in Table 2-1, the $NPSH_A/NPSH_R$ margin ratio is probably acceptable when the pumps are operating within 85 percent to 115 percent of the BEP capacity. Because the pump is operating at 14.5 cfs (6,500 gpm), which is outside of 85 percent to 115 percent of the BEP capacity, operation within $NPSH_A/NPSH_R$ margin ratio is questionable and may be affecting the pumping capacity and pump mechanical life.

2.2.2.2 Large Pumps in Operation

Pump system losses and head-capacity curves were developed for the following operating conditions:

- Large pump in operation.
- High North Channel WSEL.
- Low and high Walnut Pumping Station wet well WSEL.
- Friction factor C of 130 and 145.

Figure 2-8 shows the pump curve versus the head capacity curves for each of the potential operating conditions at the Walnut Stormwater Pumping Station for Pumps 2 and 4 in operation.

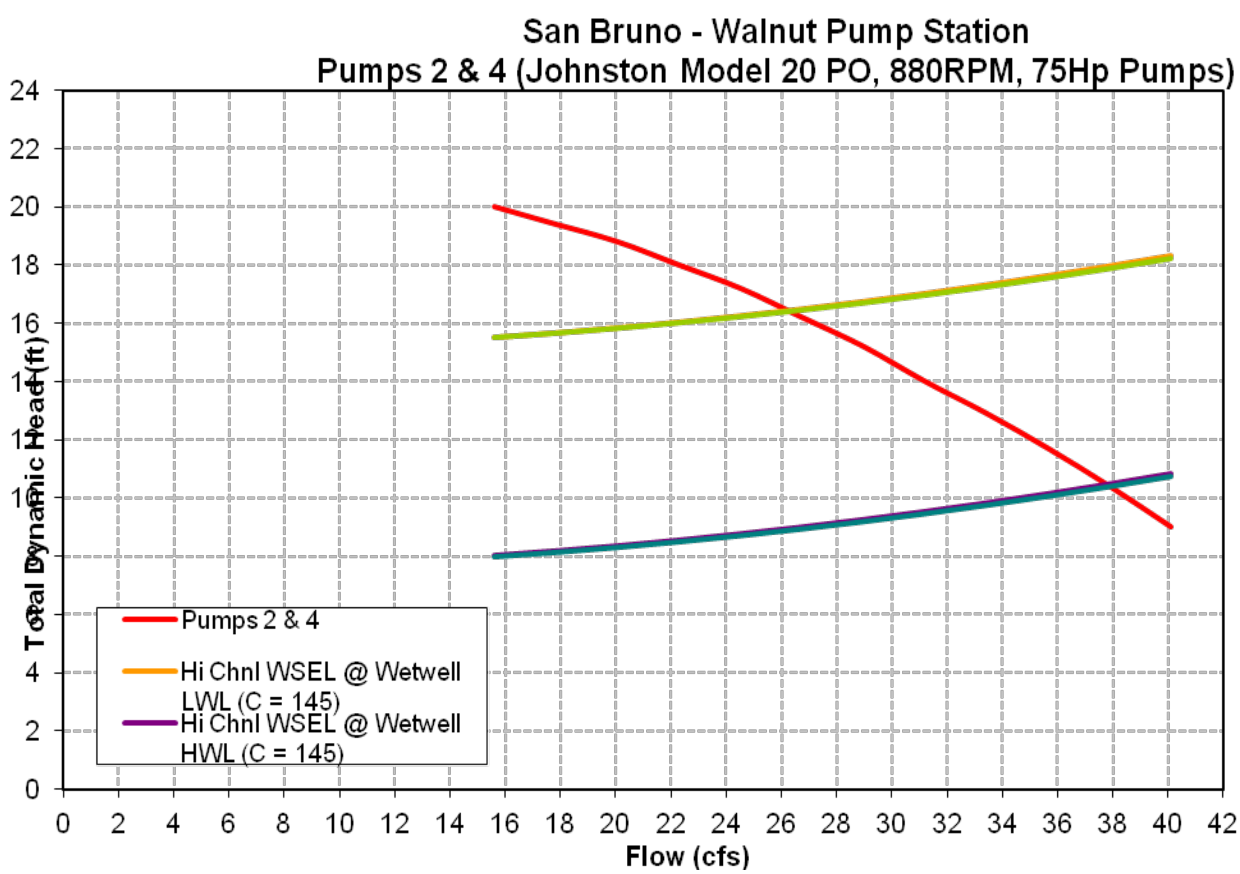

Figure 2-8. Walnut Stormwater Pumping Station: Large Pump in Operation at Friction Factor C of 130 and 145

Based on the head capacity curves in Figure 2-8, each pump can convey approximately 25 to 38 (11,200 to 17,000 gpm) per pump depending on the wet well and North Channel water surface elevations. The POR is between 25.4 to 36.5 cfs (11,400 to 16,400 gpm) based on the pump operating at its most efficient point of 31.7 cfs (14,200 gpm). If both Pumps 2 and 4 are operating at their most efficient point, approximately 63.4 cfs (28,500 gpm) of stormwater flow can be conveyed to the North Channel. This is based on a Johnston Propeller Pump Model 20 PO catalog pump curve. A catalog pump curve for the Model 20PO was used because the County of San Mateo and the pump manufacturer were unable to provide the original pump curve.

Evaluation of the bell suction velocity was performed. Since the existing Johnston Propeller Pump Model 20 PO drawings were not available, it is assumed that the pump suction does not have a suction umbrella. According to the American Pipe Manual – 18th Edition (1999) American Ductile Iron Specials – Flare Casting, the corresponding bell suction diameter for a 24-inch pipe diameter is 32-inches. Assuming the pumps can convey a maximum flow of approximately 37.9 cfs (17,000 gpm) each, the corresponding bell entrance velocity is approximately 6.8 fps. This velocity is above the recommended ANSI/HI velocity of 5.5 fps.

Minimum submergence of the pump suction was also calculated using the same methodology as for the small pumps.

Assuming the pumps can convey a maximum flow of approximately 37.9 cfs (17,000 gpm) each, the corresponding minimum submergence is approximately 7.2 feet. The wet well configuration is as cited for the small pump condition. Therefore, to maintain the Hydraulic Institute recommended calculated minimum submergence of 7.2 feet, the low wet well water level would have to be increased by approximately 4.7 feet.

The wet well level also affects the NPSH available for the pump, which also affects pump operation and performance. The $NPSH_A$ for a maximum flow for one pump operating at 37.9 cfs (17,000 gpm) is approximately 28.4 feet. The $NPSH_R$ curve for the existing pumps is approximately 31 feet. The $NPSH_A/NPSH_R$ margin ratio is 0.9. Based on the information in Table 2-1 and criteria cited for the small pumps the $NPSH_A/NPSH_R$ margin ratio is probably not acceptable when the pumps are operating within 85 percent to 115 percent of the BEP capacity. Because the pump is operating at 37.9 cfs (17,000 gpm), which is outside of 85 percent to 115 percent of the BEP capacity, operation within $NPSH_A/NPSH_R$ margin ratio is questionable and may be affecting the pumping capacity and pump mechanical life.

2.2.2.3 Wet Well Storage Volume Required

The wet well storage required was also calculated. The following ANSI/HI equation is used to calculate the approximate wet well volume required between pump cycle times:

$$Vol = T\left(\frac{Q}{4}\right)$$

where: Vol = approximate wet well volume, gallons
T = pump cycle time, minutes
Q = flow rate of largest pump in operation, gpm

Assuming that only two small pumps and one large pump are in operation and are conveying the maximum combine flow of approximately 17,000 gpm (38 cfs) with a 10 minute (600 seconds) pump cycle time, the approximate wet well volume is 42,500 gallons (5,700 cubic feet). This maximum volume is based on an inflow into the pumping station at a ½ the pumping rate. This wet well volume will need to be provided by the wet well and collection system.

2.2.2.4 Pumping Capacity

The required pumping capacity for a 25-year design storm is 45 cfs (20,200 gpm). The pumping capacity with one of the large pumps out of service is 50 cfs (40,400 gpm), which meets the pumping station required capacity of 45 cfs (20,200 gpm).

2.3 Pumping Assessment

The existing pumps, motors, and adjustable speed drives are relatively new. The larger capacity pumping equipment (Pumps 2 and 4) was installed approximately 12 years ago. At that time, one of the smaller capacity pumps (Pump 1) was retrofitted and adjustable speed drives were provided for all pumps. Operating staff appear satisfied with pump reliability and pumping capacity adequacy of the equipment. No pumping improvements are recommended at this time.

2.4 Wet Well and Screening and Debris Removal

The trash rack preceding the pump intakes consist of heavy duty galvanized grating. The main bars are 5-inches by 3/4-inches spaced at 2-3/8-inch on center. The cross bars are 3/8-inch-diameter bars at a spacing of 4 inches on center. The rack is set in the entrance channel at an angle of 60 degrees to horizontal. Figure 2-9 shows the screening configuration.

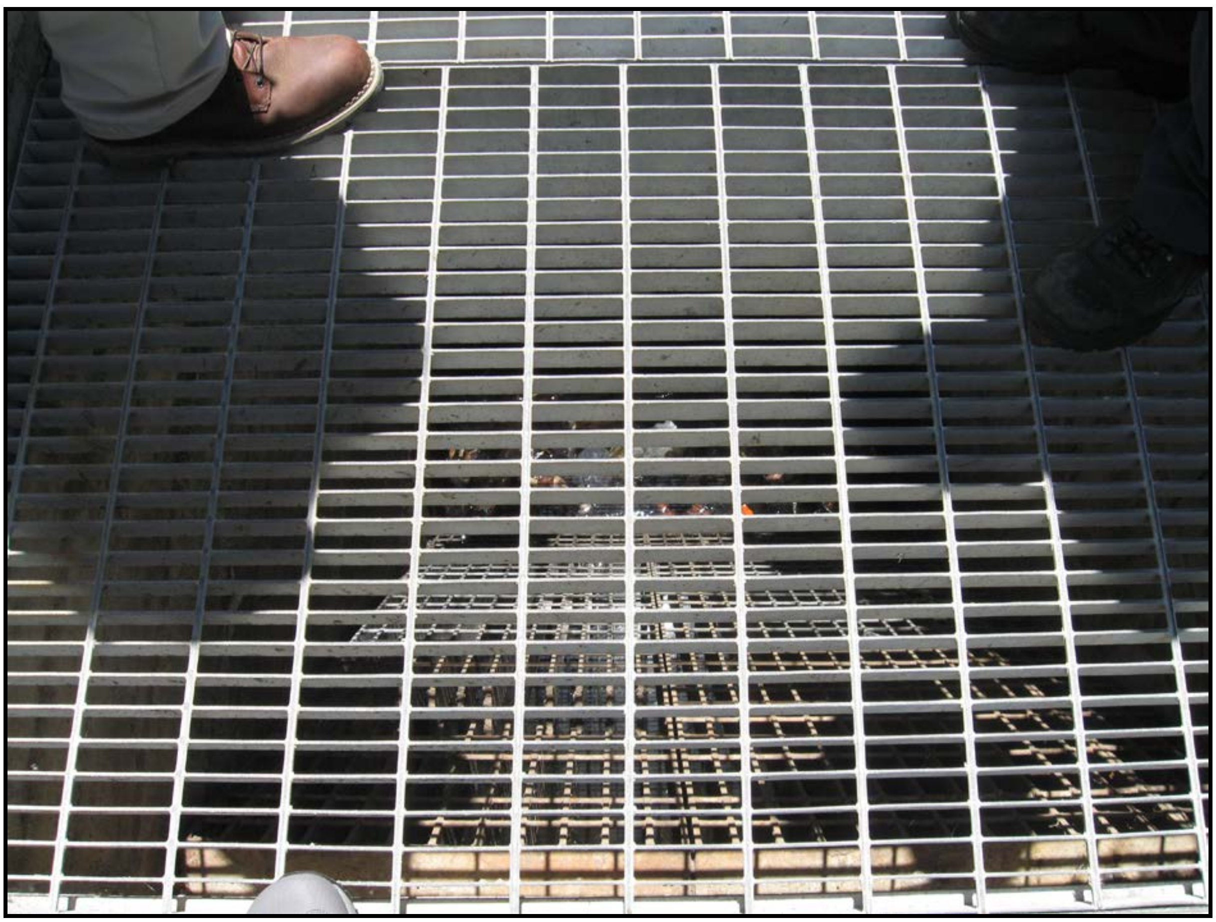

Figure 2-9. Walnut Stormwater Pumping Station: Screen Grating

During a storm event, debris that is suspended in the stormwater drainage system is transported to the pumping station and deposited on the trash racks. Because of the configuration of the bars, debris removal from the trash rack is extremely difficult and presents a safety hazard because the top grating must be removed to manually rake the debris to the surface. Because of the safety issues, debris is not removed and it builds up on the face of the trash racks. The resulting debris accumulation significantly restricts the flow of water into the pump wet wells and causes buildup of runoff water upstream within the drainage system.

The wet wells are emptied rapidly by the pumps because the restricted flow entering the wet wells is considerably less than the overall station rated pumping capacity. As a result, the pumps cycle on and off frequently. The frequent cycling of the pumps over heat the pump motors. When the pump motor overheats, the electrical protection system causes the motor to shut down. When this happens, the circuit reset must be actuated manually. Pump motor overheating is further aggravated when the pump discharge piping is surcharged in the North Channel. The discharge head is increased in this condition causing a reduction in the pump speed and additional loading on the pump motor.

A new automated mechanically cleaned bar screen is recommended. The County and City have investigated a bar screen manufactured by Duperon. This or a similar type bar screen would work in this situation. The debris would be automatically raked to the surface and deposited in a container or on the ground. Because of the site limitation, the debris would need to be manually removed from the screenings area.

2.5 Structural Assessment

The seismic evaluation of the Walnut Stormwater Pumping Station structure follows the directives of ASCE 31. The evaluation process is described in Chapter 1.0, Figure 1-1 of ASCE 31, a copy of which is included in Appendix D. The evaluation process consists of the following three tiers:

- Screening Phase (Tier 1)
- Evaluation Phase (Tier 2)
- Detailed Evaluation Phase (Tier 3)

The Tier 1 screening phase identifies potential seismic hazards of structures. The screening phase consists of obtaining general information of the facilities such as record drawings and geotechnical information; a site visit; and completing three sets of checklists that allow an evaluation of the structural, nonstructural, and geologic hazard elements of the structures and site condition. Simplified calculations are performed to determine compliance, or non-compliance, with the criteria of the ASCE 31 standard. A list of potential deficiencies is reported based on the information from the Tier 1 analysis.

The Tier 2 evaluation phase, if deemed necessary, is used for those structures identified in Tier 1 to have potential deficiencies. The evaluation uses more rigorous calculations to assess the deficiencies of the structures. If the structures are found to be deficient in Tier 2, then the deficiencies are summarized and reported. Recommendations for mitigating the deficiencies and cost estimates are included in the report.

BC has performed a Tier 1 evaluation for the Walnut Stormwater Pumping Station for the Life Safety Performance Level criteria. Under this performance level, structural collapse is not expected to occur, and damage that may occur can be repaired.

It should be noted that the Tier 1 phase identifies only potential deficiencies in the lateral-load-resistance systems of structures, not necessarily actual vulnerability. BC recommends doing a Tier 2 evaluation of the facilities when potential deficiencies are found. Such an evaluation may reveal that some locations identified are actually adequate, while possibly demonstrating that other locations need remedial work.

2.5.1 Available Structural Information

The above-ground portion of the Walnut Stormwater Pumping Station structure was designed in 1967 and built on a concrete structure that already existed, which extends approximately 3 feet above the ground surface. The lateral-load-resisting system of the above-ground structure consists of concrete shear walls that extend through the lower portion of the height. The roof framing is of steel beams. The structure is supported on a below-grade concrete basement structure, which bears directly on the soil.

A site visit was conducted on September 22, 2009. Only the above-ground portion of the pumping station was available for view. The top of roof was not observed. No major structural deficiencies were observed, though the City and County personnel noted that roof leaks have been observed.

The nominal material properties for the 1967-vintage structure, as stated on the drawings, are: concrete compressive strength at 28 days equal to 3,000 pounds per square inch (psi). Structural steel used for the roof beams conforms to ASTM A36. Concrete masonry and reinforcing steel strength were not noted on the drawings, but compressive strength at 28 days is assumed to be equal to 1,500 psi, and reinforcing steel yield strength is assumed to be 40,000 psi. The existing-before-1967 portion of the Walnut Stormwater Pumping Station is assumed to have reinforcement and be of similar strength as the other concrete.

For this evaluation, the Walnut Stormwater Pumping Station is classified as Building Type RM1, "Reinforced Masonry Bearing Walls with Flexible Diaphragms". The structure is a single-story, with below-grade wet wells. The underground portions are concrete structures of non-building types.

2.5.2 Structural Findings

BC has determined that most portions of the Walnut Stormwater Pumping Station meet the seismic criteria for the Life Safety Performance Level.

Of the 33 criteria contained in the ASCE 31 Tier 1 checklists for Building Type RM1, "Reinforced Masonry Bearing Walls with Flexible Diaphragms", which describes the structure, fourteen apply to this structure. Of those criteria, the Walnut Stormwater Pumping Station is not deficient. The item shown in Table 2-2 is in addition to those covered in ASCE 31. The potential deficiency found can be corrected at a cost significantly less than the cost of replacement.

Table 2-2 summarizes the Tier 1 screening phase potential deficiencies.

Table 2-2. Tier 1 Screening Phase Potential Deficiencies

Location	Potential Deficiency
Walnut Stormwater Pumping Station	Roof leaks

2.6 Ventilation

The ventilation within the Walnut Stormwater Pumping Station building is dependent on engine operation. When the engine is not running, the building has only passive ventilation through the two intake louvers. When the engine is running, the building has induced ventilation from the engine's radiator, with outside air coming in the two intake louvers and exiting through the radiator exhaust louver. The three louvers are each 4-1/2 feet by 6 feet. The upper level of the building is about 6,000 cubic feet; 100 cubic feet per minute of airflow will provide one air change per hour.

BC design guidelines call for six to ten air changes per hour for this type of building and it is likely that the engine is providing at least this amount of ventilation; the louvers are sized for roughly 100 air changes per hour. BC recommends the installation of a supply fan for positive ventilation of the building and particulate filters on the intake louvers to minimize dust infiltration. It is desirable to provide additional air flow for cooling of the electrical components (refer to paragraph 2.8.8 for additional information). BC would recommend a thermostatically controlled supply fan for this.

The lower level of the building is a wet well; it is not ventilated, it does not have easy egress, and it is treated as a confined space.

2.7 Natural Gas System

The pumping station has no propane storage. The Walnut Stormwater Pumping Station is served with a buried natural gas line that fuels an engine generator; the piping and components show some corrosion but remain suitable for their purpose.

2.8 Electrical Power and Control System

This section discusses electrical and instrumentation systems at the Walnut Stormwater Pumping Station. BC inspected and evaluated the electrical system at the Walnut Stormwater Pumping Station. The following assessment is based upon field investigation and record drawings.

2.8.1 Utility Service

The Walnut Stormwater Pumping Station receives 480V, 3-phase, 4-wire electrical service from Pacific Gas & Electric Company (PG&E) via a pole-mounted 150KVA transformer. PG&E's meter (see Figure 2-10) is located outside, next to the entrance door. Although a neutral wire is brought into the metering cabinet (PG&E requirement), it is not used, since no equipment is connected to 277 volts (line-neutral). The main service disconnect consists of a stand-alone circuit breaker located inside the building. Rating of the service is 400 amperes (A). Though the utility transformer rated current (180A) is much less than the service rating, the transformer has sufficient capacity to supply the expected peak electrical load of 125 hp at peak flow.

The utility service was installed in 1997 to replace the smaller service installed in 1968 as part of a pumping station upgrade project.

Figure 2-10. Walnut Stormwater Pumping Station: Utility Electric Meter Panel

2.8.2 Grounding

One ground rod is visible outside the pumping station below the metering cabinet. BC recommends the grounding be brought up to current electrical code by testing to assure less than 25 ohms. An alternative is to install a second ground rod and bond it to the existing rod, which is the recommended approach.

2.8.3 Main Circuit Breaker

Electrical power from the utility service terminates at the main circuit breaker (MCB) located inside the pumping station next to the motor control center, in its own enclosure (see Figure 2-11). The breaker serves as the main utility power disconnect for the pumping station and limits current into the pumping station. The main breaker is rated for 400A. The MCB appears to be a type KDB manufactured by Cutler-Hammer. The enclosure cover was not removed to confirm this. KDB breakers have a 35,000A short circuit current interrupt/withstand rating, which is much higher than the utility transformer can supply. The breaker has been marked with a "35KA" in felt pen, which seems to substantiate the interrupt capability. In any case, the MCB is certainly adequate to interrupt short circuits supplied by the utility service.

Figure 2-11. Walnut Stormwater Pumping Station: MCC (extreme left) Main Breaker, ATS (center), and Generator Breaker (extreme right, partial).

2.8.4 Automatic Transfer Switch

An automatic transfer switch (ATS) directs power to the pumping station electrical loads. Utility power is connected to the ATS to serve as the normal power source. The standby generator is connected to the ATS to provide an alternate power source to the pumping station. The switch was manufactured by Automatic Switch Company (ASCO) and appears to have been installed as part of the power system upgrade in 1997.

2.8.5 Standby Generator

A natural gas fuel engine-driven generator provides an alternate power source to the pumping station. The generator is shown in Figure 2-12. Rating of the generator is 100kW, 125KVA. The generator appears to have been installed in 1968. The source of fuel is a metered gas service from PG&E.

Operations staff reports that the testing time for the generator is limited to 12 hours per year by the Bay Area Air Quality Management District. Standby generators seldom wear out, since they only operate during power outages. However gasket and seals begin to leak with time. Often, the electrical controls wear out before the engine. Since the generator controls (control panel) is more than 40 years old, it is at the end of the expected service life for electrical control equipment. It can still be maintained, but it will probably become increasingly difficult to maintain and will need maintenance/repair more frequently.

It is questionable that the generator has sufficient capacity to operate the two smaller pumps plus one of the larger pumps. The motor rated KVA is slightly larger than the generator rated KVA. The pump motors are controlled by AFDs, so harmonic currents (above 60Hz) will also be present, tending to cause overheating of the generator windings. A rough rule of thumb is that an extra 10 percent of current will be circulating due to harmonics. The input filters on the drive will mitigate the harmonic current to some extent. This will be balanced against the probable fact that the air cooling the generator will be lower than the generators rated ambient air temperature (usually 40 decrees C), which means a small amount of extra power may be available from the generator without damage. Ability to operate the pumping station with one (any) pump out of service is another reason that the generator should probably be replaced with a unit rated at least 150kW/188KVA. At a minimum, BC recommends that the standby generator be refurbished including a new control panel. As an alternative to refurbishment, the generator could be completely replaced with a new generator and controls.

Figure 2-12. Walnut Stormwater Pumping Station: Standby Generator

2.8.6 Standby Generator Circuit Breaker

A separately enclosed molded case circuit breaker serves as the overcurrent protection for the standby generator. It appears to be connected electrically between the generator and the ATS and is attached to the ATS enclosure.

2.8.7 Motor Control Center

The ATS directs power to a motor control center (MCC) that serves as the main connection point for electrical power distribution in the pumping station. The date on the nameplate indicates it was manufactured in 1997. The MCC is rated 600A, 480V, 3-phase, 3-wire. The MCC nameplate short circuit current interrupt/withstand rating is 65,000A, which is much higher than the utility transformer can supply. Half the MCC houses a motor starter for the dewatering pump, the 120V lighting panel, and associated step-down transformer. The other half is a control section. Surprisingly, it contains no controls for the main pumps or circuit breakers. Rather, bus taps supply power to the pump controllers from the MCC.

At only 12 years old, the MCC has not reached half of its expected service life of 25 years. Being installed indoors, the MCC is well protected and should have at least another 20 years of service life if well maintained. This is true for the other electrical service equipment including the main and standby generator circuit breakers and the ATS.

Article 110.26(A)(1) of the CEC requires a clear working space in front of MCCs. The ATS protrudes into this specified working space by a small amount, technically creating a violation. The specified clear working space for this condition is 42 inches. BC recommends that the authority having jurisdiction be consulted as to whether or not this must be rectified, or can be left as is until the next replacement of the electrical system expected to be necessary in about 20 years.

Figure 2-13. Walnut Stormwater Pumping Station: Electrical Equipment Lineup; Standby Generator (far left), AFDs (left), MCC (right) ATS and Generator Breaker (far right)

2.8.8 Adjustable Frequency Drives

Adjustable frequency drives (AFD) serve as pump drives. Three drives are model ACS501, manufactured by Asea-Brown Boveri (ABB). One (Pump 3) drive has been replaced with a model SV9000 AFD manufactured by C-H.

The AFDs are installed side by side, next to the motor control center. Staff reports that the AFDs overheat. They are designed to be side ventilated, and are installed with approximately two inches between them. Manufacturer (ABB) installation instructions recommend four inches. It appears some duct work has been added to the tops of the drive cabinets in an effort to improve cooling. Portable fans have also been positioned in front of the AFDs for the same purpose.

ABB's instructions state that 240 cubic feet per minute (cfm) of air is required for cooling of a 25 hp AFD and 330 cfm for a 75 hp unit. The heat loss and cooling air requirements are presented in Table 2-3.

Table 2-3. Equipment Heat Loss and Cooling Air Summary		
Item	Approximate Losses (watts)	Manufacturer Recommended Cooling Air CFM If Installed In Cabinet
Pump 1 30 hp motor (efficiency of 85 percent)	3357	
Pump 1 adjustable frequency drive (30 hp rating; efficiency of 97 percent)	560	240
Pump 1 adjustable frequency drive harmonic filter	75	
Pump 2[1] 75 hp motor (efficiency of 91.5 percent)	4756	
Pump 2[1] adjustable frequency drive (75 hp rating; efficiency of 97 percent)	1680	330
Pump 2[1] adjustable frequency drive harmonic filter	150	
Pump 3 25 hp motor (efficiency of 85 percent)	3357	
Pump 3 adjustable frequency drive (30 hp rating; efficiency of 97 percent)	560	240
Pump 3 adjustable frequency drive harmonic filter	75	
Total	14570[2]	810[3]

[1]Assumes Pump 4 is standby unit

[2]Calculation is not comprehensive, only for pumping systems. Does not include other equipment losses and lighting.

[3]Minimum air flow recommended by BC to exhaust heat for 3 pumps in operation. Does not include other heat sources.

A simple improvement would be to add in-line fans to the ducts at the top of the AFD cabinets. They are relatively inexpensive. A control relay would need to be added to each AFD to turn the fan on when each pump is operated.

If the AFD heat sink is not clean, it will not be able to dissipate the expended heat, and the AFD's thermal protection will operate, stopping the AFD and causing a fault indication. The temperature of the heat sink should be 158 degrees F (70 degrees C), or lower. The temperature of the heat sink can be read from the control panel display, (operating data parameter 8). A similar procedure is probably possible with the Cutler-Hammer AFD. It should be confirmed that the heat sinks of the AFDs are clean and operating within prescribed temperature limits.

Even if hot air is effectively removed from the AFDs themselves, the heat must be removed from the building. Table 2-3 shows the estimated heat given off from most of the heat sources in the room when the pumps are in operation. A minimum of 1500 cfm of outside air would need to be brought into the room to keep the interior air temperature at 90 degrees Farenheight with outside air temperature of 60 degrees. No exhaust fan was observed. BC recommends a 2000 cfm supply fan be added to provide cooling air for the electrical equipment. The fan should direct air flow towards the AFDs, so should be in the wall opposite the AFDs or in the ceiling directly in front of the AFDs. A thermostat could be used to control the fan. The thermostat should be located next to the AFDs and turn the fan on when room temperature reaches 80 degrees Fahrenheit.

Another cause of overheating of the drives may be the short-cycling of the pumps. When the trash rack clogs, the pumps start and stop frequently. This can cause overheating of the motors, and possibly, the drives also. It should be confirmed that the AFD overheating condition is not from pump short-cycling. If it is from short-cycling, the controls should be modified to prevent this from happening. Pump starting should be limited to two starts per hour per pump.

The AFDs have line reactors installed as input filters. These perform two functions. First, they lower the waveform distortion on the power system due to harmonic currents. Second, they limit the amount of current that reaches the AFD if there is a short in the AFD.

Even if the issues of overheating of the motors and drives are resolved, the AFDs are 12 years old and approaching their expected end of life. Expected service life of this equipment is about 15 years. One of the original AFDs has already been replaced. Even though they may last longer, it should be expected that the three original AFDs will need to be replaced in the next five years.

Figure 2-14. Walnut Stormwater Pumping Station: Adjustable Frequency Drives

2.8.9 Pump Motors

The two smaller stormwater pump motors (Pumps 1 and 3) were manufactured by General Electric Company. The two larger motors (Pumps 2 and 4) were manufactured by U.S. Electrical Motors Company. All are weather-protected, open drip-proof design (WP1) vertical pump motors. None of the pump motors are considered inverter-duty by today's standards. Though not designed for use with modern AFD-type controllers with IGBT inverters, they appear to be able to survive inverter-duty service, presumably due to their close proximity to the AFD controllers. None of the motors are high efficiency. The conditions causing the reported short-cycling of the pumps should be corrected to prevent frequent pump cycling. Pump starts should be limited to two starts per hour.

Pump 1 has an oversized motor installed (30 hp). Pump 3 has a 25 hp motor installed.

Pump 2 and Pump 4 motors are rated 75 hp, 880 rpm, 91.7 percent nominal efficiency. Modern premium efficiency motors have 2 to 3 percent higher efficiencies. Because of the limited amount of run time the pumps experience, replacing them with premium efficiency motors to reduce energy costs alone is not recommended since the payback period would be very long. These motors are equipped with embedded winding thermostats for thermal protection and anti-condensation winding heaters.

Motors driven by AFDs tend to have damage to bearings due to induced current traveling through the bearings. When the pump motors are repaired or replaced, grounding brushes should be considered, especially if bearing fluting is identified by inspection of the bearings. This is more applicable for the 75 hp units because of their more significant value.

2.8.10 Instrumentation

The following observations were made on the instrumentation system:

- The main pump controls appear to be a MicroMac 2400 Level Controller manufactured by Fluid Solutions, Inc. The controller is obsolete in that Fluid Solutions no longer sells it. Expected life is about 15 years, so it will likely be necessary to replace it in the next five years. It is now being marketed as the Digi-Gage 2400 controller by EG Controls of Jacksonville, Florida. Since this is an obsolete controller, BC recommends that at lease one spare unit be kept on hand. Price is approximately $2,500.
- Level instruments at the pumping station were not observed by BC nor commented on by operations staff.
- A Guard It automatic dialer by RACO relays critical alarms to operating personnel. The dialer appears to have the capability of transmitting a message via telephone for up to four alarms, three are used (high inlet bay level, high wet well level, low wet well level). This unit is still available from RACO for about $900.

2.8.11 Miscellaneous Items

BC observed covers missing from some conduit fittings (condulets) and faceplates missing from receptacles. Also, it appears at least one hole is missing a plug in the standby generator terminal box. At least one light fixture appears to be out of service, with its junction box uncovered. These and similar items should be corrected to bring the station into compliance with the current California Electrical Code (CEC, 2007).

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3. ANGUS STORMWATER PUMPING STATION EVALUATION

This chapter discusses the Angus Stormwater Pumping Station evaluation. This chapter is divided into eight sections including documentation review; hydraulic analysis; pumping assessment; wet well and screening and debris removal; structural assessment; ventilation; natural gas system; and electrical power and control system.

3.1 Documentation Review

Results of our examination of existing documents and records for the Angus Stormwater Pumping Station are summarized below.

3.1.1 Wet Well

Flow enters the pumping station in 48-inch-diameter storm drains, one from the east and one from the south, and discharge into a sump at the east end of the pumping station. The sump is partitioned in half forming two equally sized wet wells. Trash racks are provided at the entrance to the wet wells to capture debris.

The partitions in the wet well do not meet the ANSI/HI standards for pump intake design. Because the wet well does not meet these standards, rotating flow, and thus, poor hydraulic and pipe intake conditions may exist. With poor hydraulic and inlet conditions, pump performance may be adversely affected. The following list of phenomena may occur in the wet well from the poor hydraulic and pump intake conditions: 1) free-surface vortices, 2) submerged vortices, 3) excessive pre-swirl of flow entering the pump, 4) non-uniform spatial distribution of velocity at the impeller eye, 5) excessive variations in velocity and swirl with time in the suction piping, and 6) entrained air or gas bubbles (ANSI/Hydraulic Institute, 1998). Typical symptoms of poor hydraulic conditions within a wet well are reduced flow rate, reduced head, effects on power, and increased vibration and noise.

At this time, it is not recommended that any wet well modification be considered. County and City staff have not indicated any pumping issues related to capacity. It can be very costly to make wet well changes.

3.1.2 Pumping Equipment

The pumping station contains two single stage, two speed vertical propeller pumps. The station was originally constructed in 1968. The two pumps are Johnston Model 30 PO type pumps. Each pump is rated for 30,000 gpm at 13.5 feet total head at a maximum rotational speed of 585 rpm. Each pump is fitted with a Johnston Model HG-250 vertical hollow shaft gear right angle drive having a 3 to 1 speed ratio. Each pump is driven by a propane fueled engine having a continuous rating of 110 hp and a maximum speed of 1755 rpm. Figure 3-1 shows Pump 1.

Recommendations for the pumping equipment are provided in Section 3.2.

Figure 3-1. Angus Stormwater Pumping Station: Pump 1 (110 hp.)

3.1.3 Pump Discharge

Each pump discharge is a 36-inch-diameter steel pipe. The pipe is buried and discharges into Cupid Row Canal (also known as Crystal Springs Channel) directly west of the pumping station. Each discharge pipe is provided with a 36 inch Waterman Model F10 flap gate.

Figure 3-2 shows the discharge piping and flap gates. As can be seen from Figure 3-2, cracking of the concrete encasement has occurred and the flap gates are corroded. It is recommended the concrete encasement be repaired and the flap gates be repalced.

Figure 3-2. Angus Stormwater Pumping Station: 36-inch Discharge Piping and Flap Gates

3.1.4 Pumping Station Design Flow

Based on the 1991 Storm Drain Master Plan Study, the pumping station receives storm runoff from Watershed E. The watershed covers an area of 45 acres and is shown in Figure 3-3. The area is bounded by the Southern Pacific Railroad, Belle Air Elementary School, Pine Street, and 7th Avenue. The calculated 25-year peak flow for this watershed is 34 cfs or 15,300 gpm.

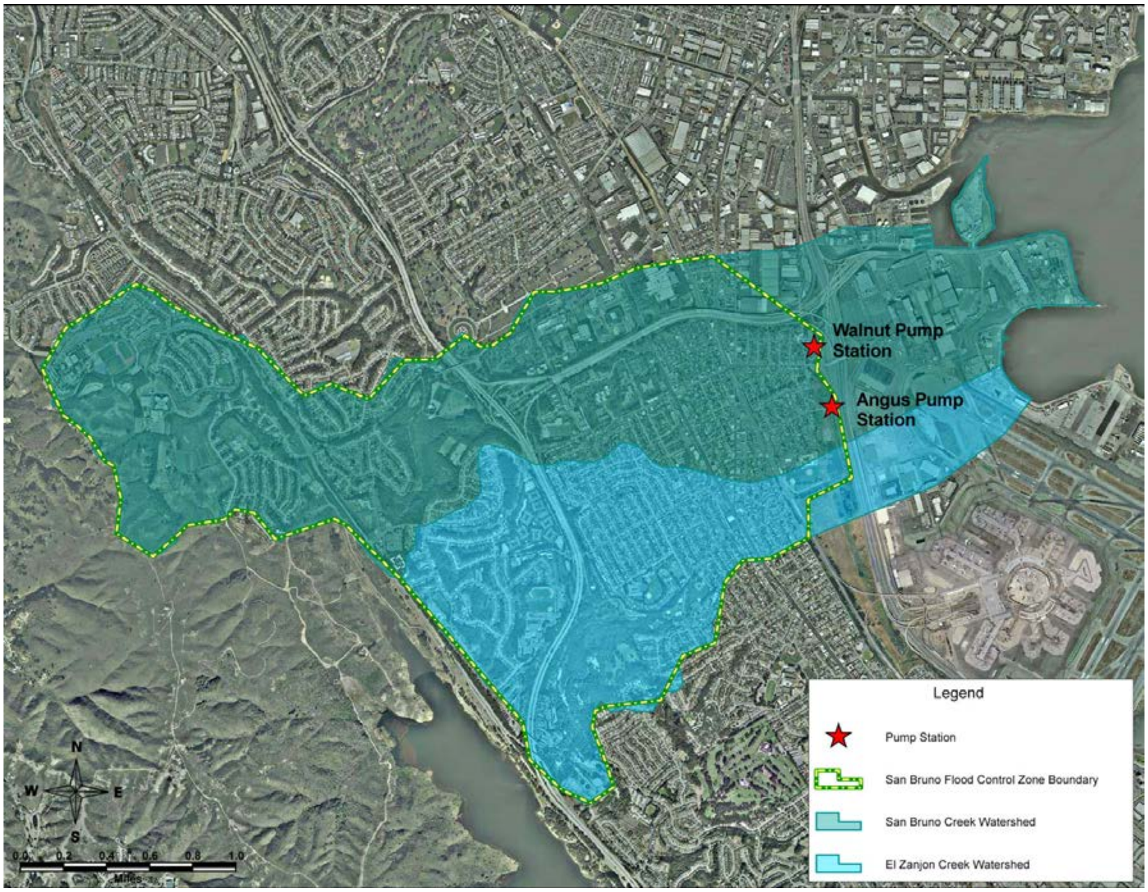

Figure 3-3. Angus Stormwater Pumping Station Watershed Area

3.2 Hydraulic Analysis

The purpose of this section is to perform a hydraulic analysis on the existing Angus Stormwater Pumping Station to determine if there is sufficient capacity to convey the 25-year stormwater flow of 34 cfs (15,300 gpm). The Angus Stormwater Pumping Station constructed in 1967 has two identical vertical propeller pumps, each with an independent discharge.

3.2.1 Available Information

The following documents were reviewed and used to develop the hydraulic analysis:

- Johnston Vertical Propeller Pump Model HG-250 Pump Curves Serial Number GA-3838, dated July 16, 1968. Refer to Appendix E for pump curves.

- San Bruno Creek Flood Control Project – New pump station site and miscellaneous details drawings dated April 1968 prepared by Wilsey and Ham. Refer to Appendix F for drawings.
- Angus Pumping Station wet well operation levels and email correspondence dated September 30, 2009, from Anna Mui, County of San Mateo. Refer to Appendix C for email correspondence.

3.2.2 Hydraulic Capacity

A pump curve versus system curve analysis was developed to evaluate the potential operating scenarios for the pumping station. Manufacturer's information was used to develop the pump curve for each pump. A mathematical model based upon the Hazen-Williams formula to calculate pipe friction loss was used to develop the system curve. A low and high operating system curve was developed to determine the potential range of pump operating conditions. Hazen Williams friction factors (C) of 130 and 145 were used to develop the high and low operating conditions. The minor losses (i.e., pipe fitting losses and valves) were calculated by multiplying the velocity head by standard fitting headloss coefficients.

Wet WSEL were provided by Anna Mui, County of San Mateo. Table 3-1 below summarizes the static head conditions.

Table 3-1. Angus Stormwater Pumping Station - Hydraulic Conditions

	Wet Well WSEL, feet		Cupid Row Canal WSEL[1], feet	
	Pump On	Pump Off	Low	High
Angus Stormwater Wet Well Low Operating Level - Pump 1 (25 hp)	3.5	-8.5	8.7	8.7
Angus Stormwater Wet Well Low Operating Level - Pump 1 (25 hp)	4.0	-8.5	8.7	8.7

[1]Top berm elevation of Cupid Row Canal per the San Bruno Creek Flood Control Project – Pump Station No. 2 (new) site and miscellaneous details drawings dated April 1968 prepared by Wilsey and Ham.

Each pump has its own dedicated 36-inch diameter discharge pipe that conveys stormwater flow into the Cupid Row Canal. Each discharge pipe has a flap gate at the end to prevent canal flow intrusion into the Angus Stormwater Pumping Station.

3.2.2.1 One Pump in Operation

A pump curve versus the system curves were developed for the following operating conditions:

- 110 hp pump in operation.
- High Cupid Row Canal WSEL.
- Low and high Angus Stormwater Pumping Station wet well WSEL.
- Friction factor C of 130 and 145.

Figure 3-4 shows the pump curve versus the system curves for each of the potential operating conditions at the Angus Stormwater Pumping Station.

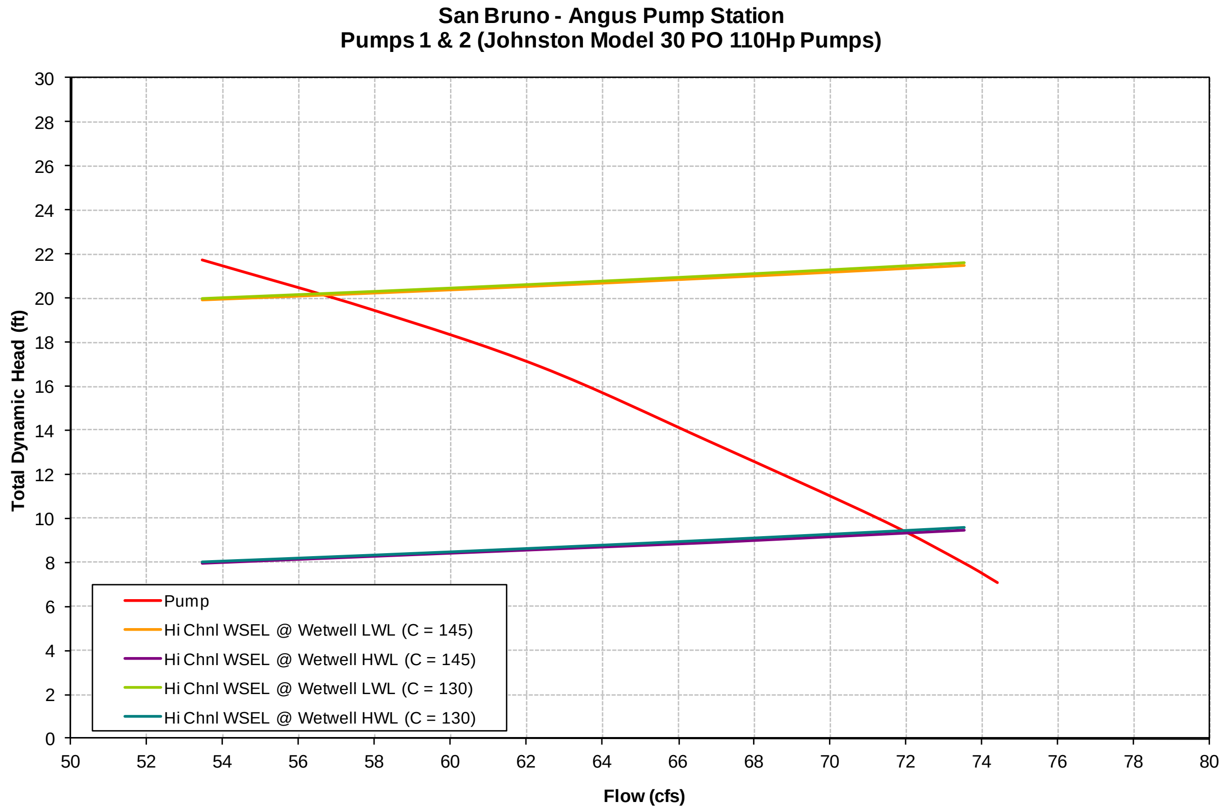

Figure 3-4. Angus Stormwater Pumping Station: 110 hp Pump in Operation at Friction Factor of 130 and 145.

Based on the head capacity curves in Figure 3-4, each 110 hp pump can convey approximately 56 to 72 cfs (25,000 to 32,300 gpm) per pump depending on the wet well and Cupid Row Canal water surface elevations. The POR, as defined by ANSI/HI, is between 51.7 to 74.3 cfs (23,200 to 33,300 gpm) based on the pump operating at its most efficient point of 64.6 cfs (29,000 gpm). If both Pumps 1 and 2 are operating at its most efficient point, approximately 129.2 cfs (58,000 gpm) of stormwater flow can be conveyed to the Cupid Row Canal.

Evaluation of the bell suction velocity was also performed. Based on the existing Johnston Propeller Pump Model 1 Stage 30 PO drawings (Appendix E), the pump has a suction bell entrance diameter of 50-inches. Assuming the pumps can convey a maximum flow of approximately 72 cfs (32,300 gpm) each, the corresponding bell entrance velocity is approximately 5.3 fps. This velocity is within the recommended ANSI/HI velocity of 5.5 fps.

Minimum submergence of the pump suction was also calculated. Sufficient submergence on the pump inlet can reduce the affect free surface vortices have on the pump performance. The following ANSI/HI equation was used to calculate the minimum submergence for the pump:

$$S = D + 0.574\left(\frac{Q}{D^{1.5}}\right)$$

where: S = minimum submergence inches
D = diameter, inches
Q = flow, gpm

Assuming the pumps can convey a maximum flow of approximately 72 cfs (32,300 gpm) each, the corresponding minimum submergence is 8.5 feet. The wet well bottom elevation is -15.5 with a low wet well WSEL of -8.5 and a high wet well WSEL of 3.5. The low wet well water level corresponds to a water depth of approximately 7 feet, and the high wet well water level corresponds to a water depth of approximately 19 feet. To maintain the ANSI/HI recommended calculated minimum submergence of 8.5 feet, the low wet well WSEL should be increased approximately 1.5 feet.

The wet well level also affects the $NPSH_A$ for the pump, which affects pump operation and performance. Inserting the data from the existing drawings, the $NPSH_A$ for a maximum flow for one pump operating at 72 cfs (32,300 gpm) is approximately 19.3 feet. The $NPSH_R$ curve for the existing pumps is approximately 25 feet. As a minimum, for pumps operating within 85 percent and 115 percent of best efficiency point capacity, BC and the ANSI/HI recommend that the minimum $NPSH_A/NPSH_R$ margin ratio be 1.3. For pumps operating outside this range, it is recommended the $NPSH_A/NPSH_R$ margin ratio be increased to 1.8. The $NPSH_A/NPSH_R$ margin ratio is 0.8. Based on the information in Table 3-1, the $NPSH_A/NPSH_R$ margin ratio is probably not acceptable when the pumps are operating within 85 percent to 115 percent of the BEP capacity. Because the lift station is operating at 72 cfs (32,300 gpm), which is outside of 85 percent to 115 percent of the BEP capacity, operation within $NPSH_A/NPSH_R$ margin ratio is questionable and may be affecting the pumping capacity and pump mechanical life.

The wet well storage required was also calculated. The following ANSI/HI equation is used to calculate the approximate wet well volume required between pump cycle times:

$$Vol = T\left(\frac{Q}{4}\right)$$

where: Vol = approximate wet well volume, gallons
T = pump cycle time, minutes
Q = flow rate of largest pump in operation, gpm

With one pump is in operation and conveying the maximum combine flow of approximately 32,300 gpm (72 cfs) with a 10 minute (600 seconds) pump cycle time, the approximate wet well volume required is 80,750 gallons (10,800 cubic feet). This maximum volume is based on an inflow into the pumping station at a ½ the pumping rate. This wet well volume will need to be provided by the wet well and collection system.

3.3 Pumping Assessment

The existing pumps, right angle gear drives and engines are over 40 years old. Due to the age of the equipment, obtaining spare parts for repair and maintaining the equipment is a significant problem. For example, the automatic clutches on the right angle gear drives no longer function. As a result, the pump-gear drive systems are directly connected thereby, eliminating a protective feature of the pumping system. Repair of the clutches can not be done due to the unavailability of the required repair parts. Under the present condition, pump shaft breakage is possible under a hydraulic transient event, which could shut down the pumping station for a significant period of time. No pumping improvements are recommended at this time.

3.4 Wet Well and Screening and Debris Removal

The trash racks preceding the pump intakes consist of heavy duty galvanized grating. The main bars are 5-inches by 3/4-inches spaced at 2-3/8-inch on center. The cross bars are 3/8-inch-diameter bars at a spacing of 4 inches on center. The racks are set in the sump at an angle of 60 degrees to horizontal. Because of the bar spacing of the grating, debris removal from the trash racks is extremely difficult. Figure 3-5 shows the screening configuration.

Figure 3-5. Angus Stormwater Pumping Station: Screen Grating

During a storm event, debris that is suspended in the stormwater drainage is transported to the pumping station and deposited on the trash racks. Because of the configuration of the bars, debris removal from the trash rack is extremely difficult and presents a safety hazard because the top grating must be removed to manually rake the debris to the surface. Because of the safety issues, debris is not removed and it builds up on the face of the trash racks. The resulting debris accumulation significantly restricts the flow of water into the pump wet wells and causes buildup of runoff water upstream within the drainage system.

The wet well is emptied rapidly by the pumps because the restricted flow entering the wet well is considerably less that the overall pumping station rated pumping capacity. As a result, the pumps cycle on and off frequently. This frequent cycling of the pumps overheat the pump engines because of the reduced pump speed. The engines remain off for a timed cool down period, which ultimately leads to no pumping and the occurrence of flooding. This condition is further aggravated when the pump discharge is the Cupid Row Canal is surcharged.

A new automated mechanically cleaned bar screen is recommended. The County and City have investigated a bar screen manufactured by Duperon. This or a similar type bar screen would work in this situation. The debris would be automatically raked to the surface and deposited in a container or on the ground. Because of site access limitations, the debris may need to be manually removed from the area.

3.5 Structural Assessment

The seismic evaluation of the Angus Stormwater Pumping Station structure follows the directives of ASCE 31. The evaluation process is described in Chapter 1.0, Figure 1-1 of ASCE 31, a copy of which is included in Appendix D. The evaluation process consists of the following three tiers:

- Screening Phase (Tier 1).
- Evaluation Phase (Tier 2).
- Detailed Evaluation Phase (Tier 3) if necessary.

The Tier 1 screening phase identifies potential seismic hazards of structures. The screening phase consists of obtaining general information of the facilities such as record drawings and geotechnical information; a site visit; and completing three sets of checklists that allow an evaluation of the structural, nonstructural, and geologic hazard elements of the structures and site condition. Simplified calculations are performed to determine compliance, or non-compliance, with the criteria of the ASCE 31 standard. A list of potential deficiencies is reported based on the information from the Tier 1 analysis.

The Tier 2 evaluation phase, if deemed necessary, is used for those structures identified in Tier 1 to have potential deficiencies. The evaluation uses more rigorous calculations to assess the deficiencies of the structures. If the structures are found to be deficient in Tier 2, then the deficiencies are summarized and reported. Recommendations for mitigating the deficiencies and cost estimates are included in the report.

BC has performed a Tier 1 evaluation for the Angus Stormwater Pumping Station for the Life Safety Performance Level criteria. Under this performance level, structural collapse is not expected to occur, and damage that may occur can be repaired.

It should be noted that the Tier 1 phase identifies only potential deficiencies in the lateral-load-resistance systems of structures, not necessarily actual vulnerability. BC recommends doing a Tier 2 evaluation of the facilities when potential deficiencies are found. Such an evaluation may reveal that some locations identified are actually adequate, while possibly demonstrating that other locations need remedial work.

3.5.1 Available Structural Information

The Angus Stormwater Pumping Station structure was originally designed in 1967. The lateral-load-resisting system of the above-ground structure consists of reinforced concrete block masonry shear walls with corrugated metal roof diaphragms. The roof framing is of steel beams. The Angus Stormwater Pumping Station is supported on a below-grade concrete basement structure, which in turn bears directly on the soil.

A site visit of was conducted on September 22, 2009. Only the above-ground portions of the pumping station were available for view. The top of roof was not observed. No major structural deficiencies were observed, though the City and County personnel noted that roof leaks have been observed, and minor peeling of paint at the pumping station was seen.

The 1967 drawings were incomplete. The nominal material properties for the 1967-vintage structure, as stated on the drawings, are: concrete compressive strength at 28 days equal to 3,000 psi. Structural steel used for the roof beams conforms to ASTM A36. Concrete masonry and reinforcing steel strength were not noted on the drawings, but compressive strength at 28 days is assumed to be equal to 1,500 psi, and reinforcing steel yield strength is assumed to be 40,000 psi. The drawings do not specifically state that the Angus Stormwater Pumping Station walls have reinforcement through the full height, though they show dowels at the bases.

For this evaluation, the Angus Stormwater Pumping Station is classified as Building Type RM1, "Reinforced Masonry Bearing Walls with Flexible Diaphragms." The Structures are single-story, with below-grade wet wells. The underground portions are concrete structures of non-building types.

3.5.2 Structural Findings

BC has determined that most portions of the Angus Stormwater Pumping Station meet the seismic criteria for the Life Safety Performance Level.

Of the 33 criteria contained in the ASCE 31 Tier 1 checklists for Building Type RM1, "Reinforced Masonry Bearing Walls with Flexible Diaphragms", which describes the structure, fourteen apply to this structure. Of those criteria, the Angus Stormwater Pumping Station is deficient in one. The first item shown in Table 3-2 is in addition to those covered in ASCE 31. All of these potential deficiencies found can be corrected at a cost significantly less than the cost of replacement.

Table 3-2 summarizes the Tier 1 screening phase potential deficiencies.

Table 3-2. Tier 1 Screening Phase Potential Deficiencies

Location	Potential Deficiency
Angus Stromwater Pumping Station	Roof leaks at roof hatches.
Angus Stromwater Pumping Station	Vertical discontinuity at walls; Shear wall does not continue to foundation.

3.6 Ventilation

The ventilation within the Angus Stormwater Pumping Station building is dependent on engine operation. When the engines are not running, the building has only passive ventilation through the single intake louver. When the engines are running, the building has induced ventilation from the engines' radiators, with outside air coming in the intake louver and exiting through the radiator exhaust louvers. The intake louver is 3-1/2 by 11 feet, and the radiator louvers are each 4 feet by 7 feet. The upper level of the building is about 6,300 cubic feet; 105 cubic feet per minute of airflow will provide one air change per hour.

BC design guidelines call for six to ten air changes per hour for this type of building and it is likely that the engines are providing at least the lower amount of ventilation; the intake louver is sized for roughly 70 air changes per hour. BC recommends the installation of a supply fan for positive ventilation of the building and particulate filters on the intake louvers to minimize dust infiltration.

The lower level of the building is a wet well; it is not ventilated, it does not have easy egress, and it is treated as a confined space.

3.7 Natural Gas and Propane System

There are two propane tanks at this location, providing the fuel for the engine-driven pumps. The tanks and associated piping are 30 to 40 years old and show significant signs of aging. There are no standards that have been implemented since this installation that would make these components unsuitable for continued use. There are periodic maintenance requirements for tanks of this type, and recertification may be necessary or recommended for continued use.

The propane tanks are protected by wooden bollards. These bollards should be replaced with concrete bollards to provide greater protection. Also, if any major work is completed on the propane tanks, replacement of the supports should be considered.

The pumping station is also served with a buried natural gas line that fuels a small back-up generator. This system also shows signs of aging but its integrity is intact.

3.8 Electrical Power and Control System

This section discusses electrical and instrumentation systems at the Angus Stormwater Pumping Station. BC inspected and evaluated the electrical system at the Angus Stormwater Pumping Station. The following assessment is based upon field investigation and record drawings.

3.8.1 Utility Service

The pumping station receives 120/240V, 1-phase, 3-wire electrical service from PG&E. The service originates at the end of Angus Avenue and is delivered via poles to the weather-head on the west side of the pumping station. PG&E's meter is mounted on a meter socket below the weather-head on the outside of the building. Immediately below the meter is the main service disconnect for the pumping station. The service disconnect is a circuit breaker rated at 50 amperes (A). The meter socket appears to be in good condition. The service disconnect has patches of bad corrosion on the interior dead-front cover. It is not too late to mitigate the corrosion by cleaning and painting. The breaker is dirty. It should be cleaned and inspected to assure it is still functional.

Based on a review of the electrical power lines near the site, it appears that PG&E would be able to provide 3-phase electrical service from Angus Avenue to the pumping station if the pumping station was converted to electric pumps. PG&E would have to install a transformer and make other line modifications. PG&E will need to be contacted in the design phase to confirm requirements.

Figure 3-6. Angus Stormwater Pumping Station: Electrical Service Equipment; Overhead Service to Meter and Disconnect (left) Utility Meter (middle), and Main Service Disconnect Circuit Breaker (right)

3.8.2 Grounding

A single ground rod was observed. It is located on the north side of the station, around the corner from the main service disconnect. A water pipe may have been used. BC recommends grounding be brought up to current Electrical Code by testing to assure less than 25 ohms and/or install two ground rods (probably the easier approach). If the station is converted to electrical pumps, BC recommends the grounding system be upgraded due to the higher short circuit current levels that will result from a larger electrical service.

3.8.3 Main Circuit Breaker

Electrical power from the utility service terminates in MCB located inside the pumping station next to the motor control center, in its own enclosure. The breaker serves as the main utility power disconnect for the pumping station and limits current into the station. The main breaker is rated 400A. The MCB appears to be a type KDB manufactured by Cutler-Hammer. The enclosure cover was not removed to confirm this. KDB breakers have a 35,000A short circuit current interrupt/withstand rating, which is much higher than the utility transformer can supply. Someone has marked the breaker with "35KA" in felt pen, which seems to substantiate the interrupt capability. In any case, the MCB is certainly adequate to interrupt short circuits supplied by the utility service.

3.8.4 Automatic Transfer Switch

An ATS directs power to the station electrical loads. Utility power is connected to the ATS to serve as the normal power source. The standby generator is connected to the ATS to provide an alternate power source to the station. The switch was manufactured by Square D Company. The switch does not appear to date back to the original installation in the 1960's, but rather appears to a replacement of new vintage. Based upon external appearances alone, the ATS appears in good condition.

The ATS controls distribution of electrical power from the two available sources (utility or standby generator) to a panelboard.

3.8.5 Standby Generator

An engine-driven generator provides as an alternate power source to the pumping station. Rating of the generator is 5kW, 5KVA. The generator appears to have been installed in 1968. The generator appears to use the same gaseous fuel source as the pump engines.

Standby generators seldom wear out, since they only operate during power outages. Gaskets and seals, however, begin to leak with time. This unit looks old. BC recommends that the standby generator be tested. If it tests poorly, it should be refurbished including a new control panel unless operations staff is happy with the unit as is. As an alternative to refurbishment, the generator could be completely replaced with a new generator and controls.

If the station is converted to electric-powered pumps, a new standby generator will be needed.

3.8.6 Panelboard

The ATS directs electrical power from the power sources (utility and standby generator) to a panelboard. The panelboard distributes power to the various electrical loads in the station. The panelboard appears to be in very good condition. It appears to have replaced the panel originally installed. Based upon this, the panelboard should remain serviceable for at least another 20 years, given proper maintenance.

Figure 3-7. Angus Stormwater Pumping Station: Electrical Panelboard (ATS to left)

3.8.7 Instrumentation

The following observations were made on the instrumentation system:

- The instrument panel appears to be in good condition from an external visual standpoint only. It appears to be a replacement for the original, presumably about the same time as the Walnut Stormwater Pumping Station Upgrade (1997). Instruments and electronic equipment typically have a service life of approximately 15 years. If this equipment is already 12 years old, increased maintenance due to component failure should be expected within the next 5 years.
- The main pump controls appear to be a MicroMac 2300 Level Controller manufactured by Fluid Solutions, Inc. The controller is obsolete in that Fluid Solutions no longer sells it. Expected life is about 15 years, so it will likely be necessary to replace it in the next five years. BC recommends that at lease one spare controller be kept on hand, (EG Controls version).
- A Rustrak event recorder is installed on the instrument panel. Again, expected life is about 15 years, so it will likely be necessary to replace it in the next 5 years. It appears that replacements are still available from Rustrak, although maybe not the exact same model.
- An ultrasonic level transmitter monitors wet well level for pump control and alarms. The transmitter itself was not observed and is presumed to be located inside the instrument panel. These instruments are reliable, but like most electronic devices, have an expected life of about 15 years. The sensors tend to fail more often. Recommended sensors are the larger, more expensive units when available as they are reported to have longer service life. A float-type level switch acts as a backup high level alarm to the level transmitter. Due to its infrequent activation, it should easily have another 20 years of service life expectancy.
- A Guard It automatic dialer by RACO relays critical alarms to operating personnel. The dialer appears to have the capability of transmitting a message via telephone for up to four alarms, of which it appears two are used. This unit is still available from RACO for about $900.

Figure 3-8. Angus Stormwater Pumping Station: Lift Station Control Panel

3.8.8 Pump Engine Controls

Since the pump engine controls are more than 40 years old, they are at the end of the expected service live for electrical control equipment. They can still be maintained, but it will become increasingly difficult to maintain and will need maintenance/repair more frequently.

The clutch controls are reported to be non-functional due to a failed timer that has been disconnected. This does not effect pumping operations, but makes it impossible to operate the engines without operating the pumps. This likely has negative effects on or at least adds difficulty to engine maintenance.

Because of the age of the engines and the difficulty in maintaining the engine controls, BC recommends that the engines be replaced with electric motors. If the engines are not replaced, they should be refurbished including a new control panel. New instruments should be provided on the engines also.

A standby generator will need to be provided if the engines are replaced with electrical motors. The standby generator should be rated at least 150kW/188KVA.

Figure 3-9. Angus Stormwater Pumping Station: Engine Control and Alarm Panel

3.8.9 Lighting

Staff reports that the wet well lighting is not sufficient. The wet well lighting consists of one wall-mounted floodlight located on the west exterior wall of the station. A security floodlight at the northwest corner of the station provides some additional light. These lights are not powerful enough to illuminate the wet well for good visibility. BC recommends that additional flood lighting be added for better wet well illumination. Locating the lights on the building parapet would give better protection against vandalism. A pair of 400W metal-halide flood lights on the corners of the building, focused on the wet well would greatly improved better visibility. Building mounted lights would only be able to tangentially light the trash rack. Because of this, the City may want to install lights at the midpoint of the wet well to better illuminate the rack. In this position, the lights would have to be pole mounted if vandalism is deemed a problem, adding to the cost of the installation. Since these lights would be for maintenance and wet well inspection only, a switch for them should be added inside the building.

Staff also expressed a desire for more security lighting. The security lighting consists of a motion controlled floodlight with a pair of approximately 150W lamps. For a dark site, BC recommends additional units of similar type be added. These motion controlled floodlights a inexpensive and easy to replace if vandalized. The dark site has the advantage of alerting neighbors to activity when the lights are turned on, and also minimizes energy use. Alternatively, a constantly lit site makes activity observable if the lights are on, but due to the isolated location of the lift station, BC believes activity is less likely to be noticed by neighbors. For continuous lighting, high-pressure sodium lights are recommended to minimize energy use. These units are much more expensive to install and replace. Lights will have to have individual integral photocells, or a lighting contactor will have to install them with photocell or a time clock to control them. Energy consumption will be greatly increased with this approach. Due to its increased cost of installation, and maintenance, as well as increased energy use, BC recommends that the constantly lit site approach not be used.

3.8.10 Miscellaneous Fixes

A mast (conduit) is located on the west parapet of the building. It appears to support a photocell that is no longer used. If no longer in service, BC recommends that the mast be removed and the conduit capped to prevent water ingress into the building.

4. ALTERNATIVES AND CONSTRUCTION COST DEVELOPMENT

This chapter develops project elements for rehabilitation of the Walnut and Angus Stormwater Pumping Stations. The project elements are developed based on the evaluation results from Chapters 2 and 3. The rehabilitation alternative is then compared to construction of a new stormwater pumping station located near each existing pumping station.

4.1 Rehabilitate Existing Stormwater Pumping Stations

This section develops the project elements for rehabilitation of the existing pumping stations. A separate section is provided for each pumping station. Construction costs for each rehabilitation alternative are also provided in this section.

4.1.1 Walnut Stormwater Pumping Station

Based on the results of Chapter 2, it is recommended that rehabilitation of the Walnut Stormwater Pumping Station consist of the following project elements:

- Coat the 16-inch diameter discharge piping and flap gates.
- Replace the existing grating used for capturing debris with an automated mechanically cleaned bar screen.
- Repair roof.
- Provide thermostatically controlled supply fan rated at six to ten air exchanges per hour for positive ventilation. Provide particulate air filters on intake louvers to minimize dust infiltration.
- Install a second ground rod to meet current electrical codes.
- Replace existing generator and controls with a new 150 kW unit.
- Replace AFDs or convert existing pumps to constant speed pumps.
- Replace main pump controller.
- Rehabilitate miscellaneous electrical components to meet current electrical code requirements. See Section 2.8.11 for complete list.

Wet well and pump modifications are not recommended at this time.

4.1.2 Angus Stormwater Pumping Station

Based on the results of Chapter 3, it is recommended that rehabilitation of the Angus Stormwater Pumping Station consist of the following project elements:

- Repair concrete encasement on 36-inch discharge piping.
- Replace the existing grating used for capturing debris with an automated mechanically cleaned bar screen.
- Replace roof hatches.

- Provide supply fan rated at six to ten air exchanges per hour for positive ventilation. Provide particulate air filters on intake louvers to minimize dust infiltration.
- Recommend inspection of the propane system by a firm that specializes in certification of tanks rated for American Society of Mechanical Engineers (ASME) applications.
- Remove existing pump engines and right angle gear drives. Replace with new electrical vertical motors to drive the existing pumps.
- Install new standby generator.
- Install new ground rods to meet current electrical codes.
- Replace main pump controller.
- Replace event recorder.
- Replace site lighting.
- Rehabilitate miscellaneous electrical components to meet current electrical code requirements. See Section 3.8.10 for complete list.

Wet well and pump modifications are not recommended at this time.

4.1.3 Estimated Construction Costs

This section provides estimated construction costs for the Walnut and Angus Stormwater Pumping Stations. Table 4-1 provides estimated construction costs for rehabilitation of the Walnut Stormwater Pumping Station, while Table 4-2 provides estimated construction costs for rehabilitation of the Angus Stormwater Pumping Station. The costs are considered Class 5 estimates in accordance with the Association of the Advancement of Cost Engineering International. The construction costs are indexed to year 2009 and should be adjusted to the mid-year point of actual construction. A construction contingency of 35 percent is used and is included in each line item. The estimated construction costs do not include planning level activities, environmental reviews, legal, administration, construction period design services, change orders, and other related costs.

Table 4-1. Walnut Stormwater Pumping Station Rehabilitation Cost

Project Element	Cost, $
Coat the 16-inch diameter discharge piping and flap gates.	5,000
Replace the existing grating used for capturing debris with an automated mechanically cleaned bar screen.	500,000
Repair roof.	10,000
Provide thermostatically controlled supply fan rated at six to ten air exchanges per hour for positive ventilation. Provide particulate air filters on intake louvers to minimize dust infiltration.	35,000
Install a second ground rod to meet current electrical codes.	3,000
Replace existing generator and controls with a new 150 kW unit.	300,000
Replace AFDs or convert existing pumps to constant speed pumps.	50,000
Replace main pump controller.	20,000
Rehabilitate miscellaneous electrical components to meet current electrical code requirements. See section 2.8.11 for complete list.	15,000
Total Estimated Construction Cost	$940,000

Table 4-2. Angus Stormwater Pumping Station Rehabilitation Cost

Project Element	Cost, $
Repair concrete encasement on 36-inch discharge piping.	5,000
Replace the existing grating used for capturing debris with an automated mechanically cleaned bar screen.	750,000
Replace roof hatches.	50,000
Provide supply fan rated at six to ten air exchanges per hour for positive ventilation. Provide particulate air filters on intake louvers to minimize dust infiltration.	30,000
Recommend inspection of the propane system by a firm that specializes in certification of tanks rated for American Society of Mechanical Engineers (ASME) applications. (The estimate for this element is an allowance.)	50,000
Remove existing pump engines and convert stormwater pumps to electrical motors.	300,000
Install new standby generator.	200,000
Install new ground rods to meet current electrical codes.	5,000
Replace main pump controller.	20,000
Replace event recorder.	5,000
Replace site lighting.	5,000
Rehabilitate miscellaneous electrical components to meet current electrical code requirements. See section 3.8.10 for complete list.	5,000
Total Estimated Construction Cost	$1,425,000

4.2 Replace Existing Stormwater Pumping Stations

This section compares constructing new stromwater pumping stations to rehabilitation of the existing pumping stations. Along with development of construction costs for new pumping stations, major environmental constraints are also determined for each pumping station.

4.2.1 Estimated Construction Costs

The construction costs for new stormwater pumping stations were estimated based on cost curves from Pumping Station Design, Revised Third Edition. The cost curves had an Engineering News Record Construction Cost Index (ENR CCI) equal to 4,500, and therefore, were escalated to today's ENR CCI of 9756.

The estimated construction cost for Walnut Stormwater Pumping Station ranges from $4,000,000 to $6,000,000. This compares to $840,000 to rehabilitate the pumping station.

The estimated construction cost for Angus Stormwater Pumping Station ranges from $3,000,000 to $5,000,000. This compares to $1,425,000 to rehabilitate the pumping station.

4.2.2 Environmental Constraints

The environmental constraints are significantly different for rehabilitation versus new stormwater pumping stations. A categorical exemption can most likely be used for rehabilitation of the existing stormwater pumping station since no new capacity is being added and the equipment is only being replaced. New pumping stations will require an environmental impact report. Additional land will be required and this may impact the local habitat.

5. RECOMMENDATIONS

This chapter provides recommendations for the Walnut and Angus Stormwater Pumping Stations.

5.1 Walnut Stormwater Pumping Station

The recommended project for the Walnut Stormwater Pumping Station is rehabilitation of the pumping station. The estimated cost of rehabilitation is $940,000 compared to $4,000,000 to $6,000,000 for a new stormwater pumping station.

The recommended project elements for a rehabilitated stormwater pumping station are the following:

- Coat the 16-inch diameter discharge piping and flap gates.
- Replace the existing grating used for capturing debris with an automated mechanically cleaned bar screen.
- Repair roof.
- Provide thermostatically controlled supply fan rated at six to ten air exchanges per hour for positive ventilation. Provide particulate air filters on intake louvers to minimize dust infiltration.
- Install a second ground rod to meet current electrical codes.
- Replace existing generator and controls with a new 150 kW unit.
- Replace AFDs or convert existing pumps to constant speed pumps.
- Replace main pump controller.
- Rehabilitate miscellaneous electrical components to meet current electrical code requirements. See Section 2.8.11 for complete list.

Wet well and pump modifications are not recommended at this time.

5.2 Angus Stormwater Pumping Station

The recommended project for the Angus Stormwater Pumping Station is rehabilitation of the pumping station. The estimated cost of rehabilitation is $1,425,000 compared to $3,000,000 to $4,000,000 for a new stormwater pumping station.

The recommended project elements for a rehabilitated stormwater pumping station are the following:

- Repair concrete encasement on 36-inch discharge piping.
- Replace flap valves on 36-inch discharge piping.
- Replace the existing grating used for capturing debris with an automated mechanically cleaned bar screen.
- Replace roof hatches.
- Provide supply fan rated at six to ten air exchanges per hour for positive ventilation. Provide particulate air filters on intake louvers to minimize dust infiltration.

- Inspection of the propane system by a firm that specializes in certification of tanks rated for ASME applications.
- Remove existing pump engines and right angle gear drives. Replace with new electrical vertical motors to drive the existing pumps.
- Install new standby generator.
- Install new ground rods to meet current electrical codes.
- Replace main pump controller.
- Replace event recorder.
- Replace site lighting.
- Rehabilitate miscellaneous electrical components to meet current electrical code requirements. See Section 3.8.10 for complete list.

Wet well and pump modifications are not recommended at this time.

APPENDIX A: WALNUT PUMPING STATION: EXISTING MANUFACTURER PUMP CURVES

Pump 1 and 3 -Johnston Vertical Propeller Pump Model 14PO Pump Curves Serial Number GA-3881-82, dated July 23, 1968

Pump 2 and 4 - Johnston Vertical Propeller Pump Model 14PO Pump Curves Serial Number 97JT2694 A, dated February 1998

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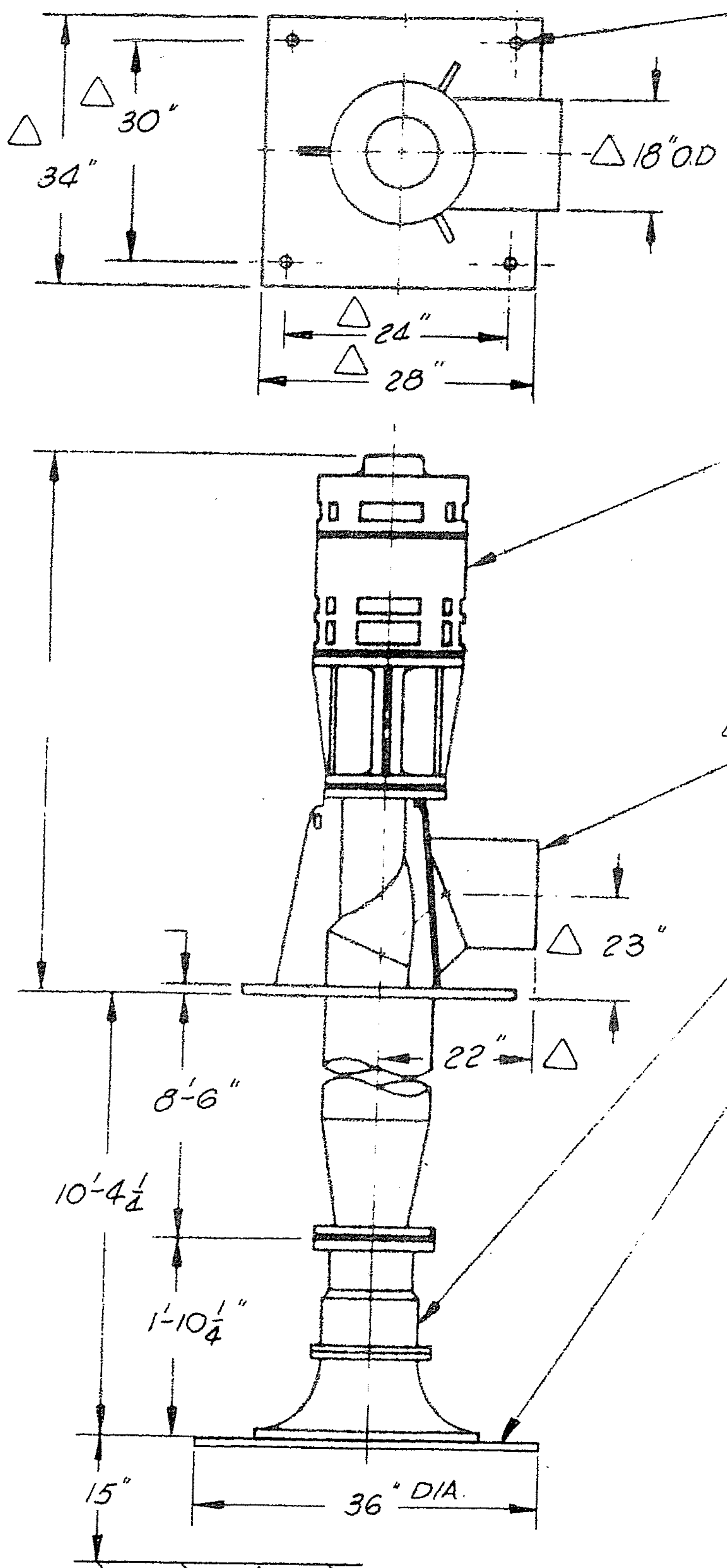
JOHNSTON VERTICAL PROPELLER PUMP

△ 4 — 1" DIA. HOLES



CONDITIONS
U.S. GALLONS PER MINUTE — 5500
TOTAL DYNAMIC HEAD IN FT — 16.5

△ VERTICAL HOLLOW SHAFT MOTOR
HP — 25 PHASE — CYCLE —
VOLTAGE — RPM — 1175
ENCLOSURE —

△ SURFACE DISCHARGE ELBOW — 18" O.D.

JOHNSTON PUMP CO. TO FURNISH
BOWL ASSEMBLY — 1 STAGE 14" PO
AND 1 SECTION OF COLUMN PIPE

SUCTION UMBRELLA

CUSTOMER: SAN MATEO COUNTY
SAN BRUNO CREEK FLOOD CONTROL
CONTRACTOR: Mc GUIRE & HESTER
PO #
JOHNSTON SERIAL NO. GA-3881-82

NOTE: DO NOT USE FOR CONSTRUCTION UNLESS CERTIFIED

THIS PRINT CERTIFIED CORRECT BY JOHNSTON PUMP COMPANY

Original Signed by
H. A. J. GREUTINK
For ______

△ EXISTING EQUIPMENT
DIM. NOT CERTIFIED

REBUILT PUMPS NO. ~~2~~ 1 & ~~3~~ 2

M.B 7-16-68

JOHNSTON PUMP CO.
GLENDORA, CALIFORNIA

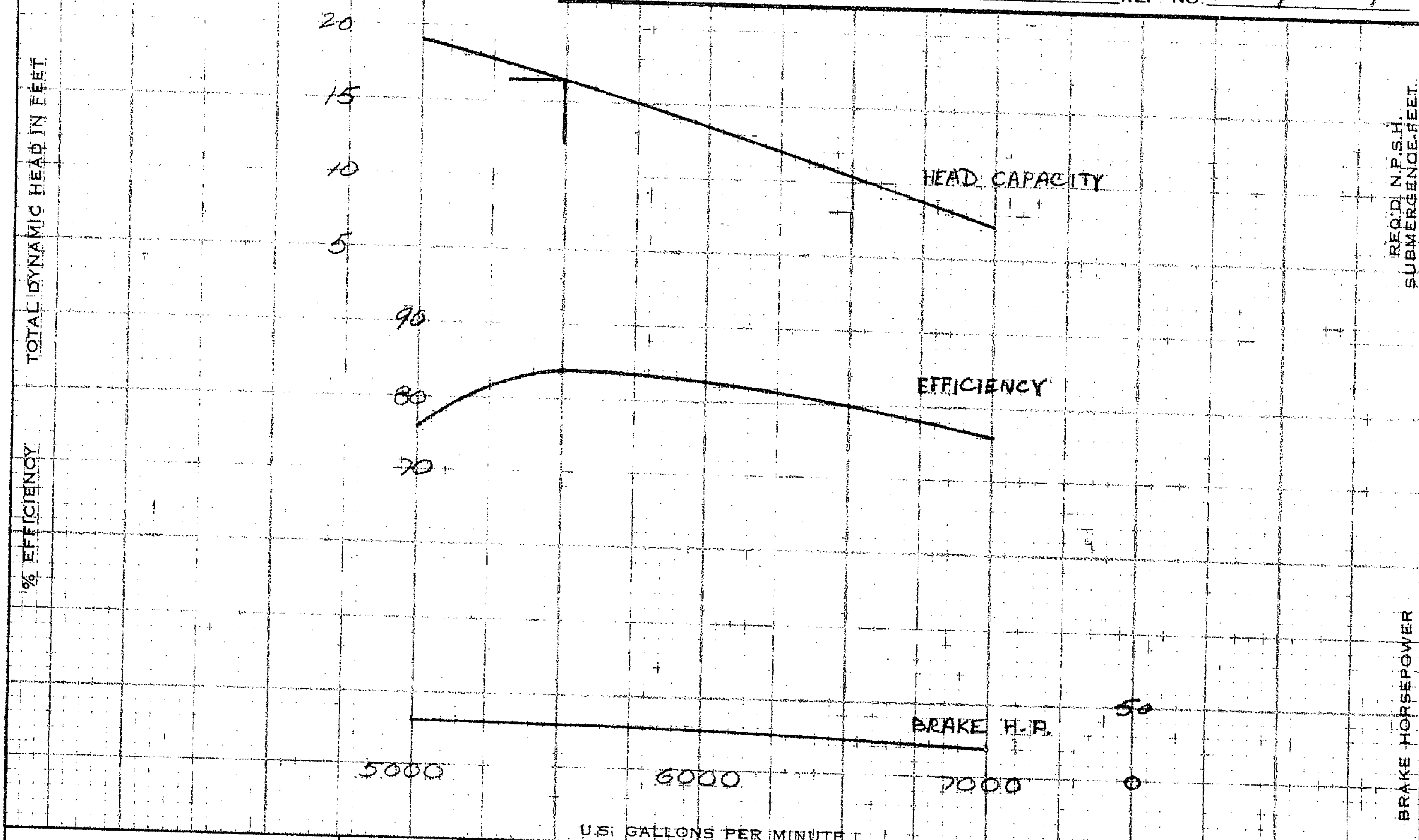
H-1600-A

NOTE: ALL COLUMN LOSSES ARE INCLUDED

JOHNSTON: REF NO GA 3881-82

DEALER: McGOIRE & HESTER REF. NO. 1896

CUSTOMER: SAN BRUNO CREEK REF. NO. Pump #2, 3



THE CAPACITY, HEAD AND EFFICIENCY GUARANTEE IS FOR THE DESIGNATED POINT ONLY: IT IS BASED ON SHOP TESTS, WHEN HANDLING CLEAR, FRESH WATER AT A TEMPERATURE OF NOT OVER 85° F. AND UNDER SUCTION CONDITIONS AS SPECIFIED IN THE CONTRACT.

IMPELLER ____ DIA. ____
BOWLS ____
LIQUID WATER
SP. GR. 1.0
DATE 7/23/68 BY DS

JOHNSTON PUMP CO.

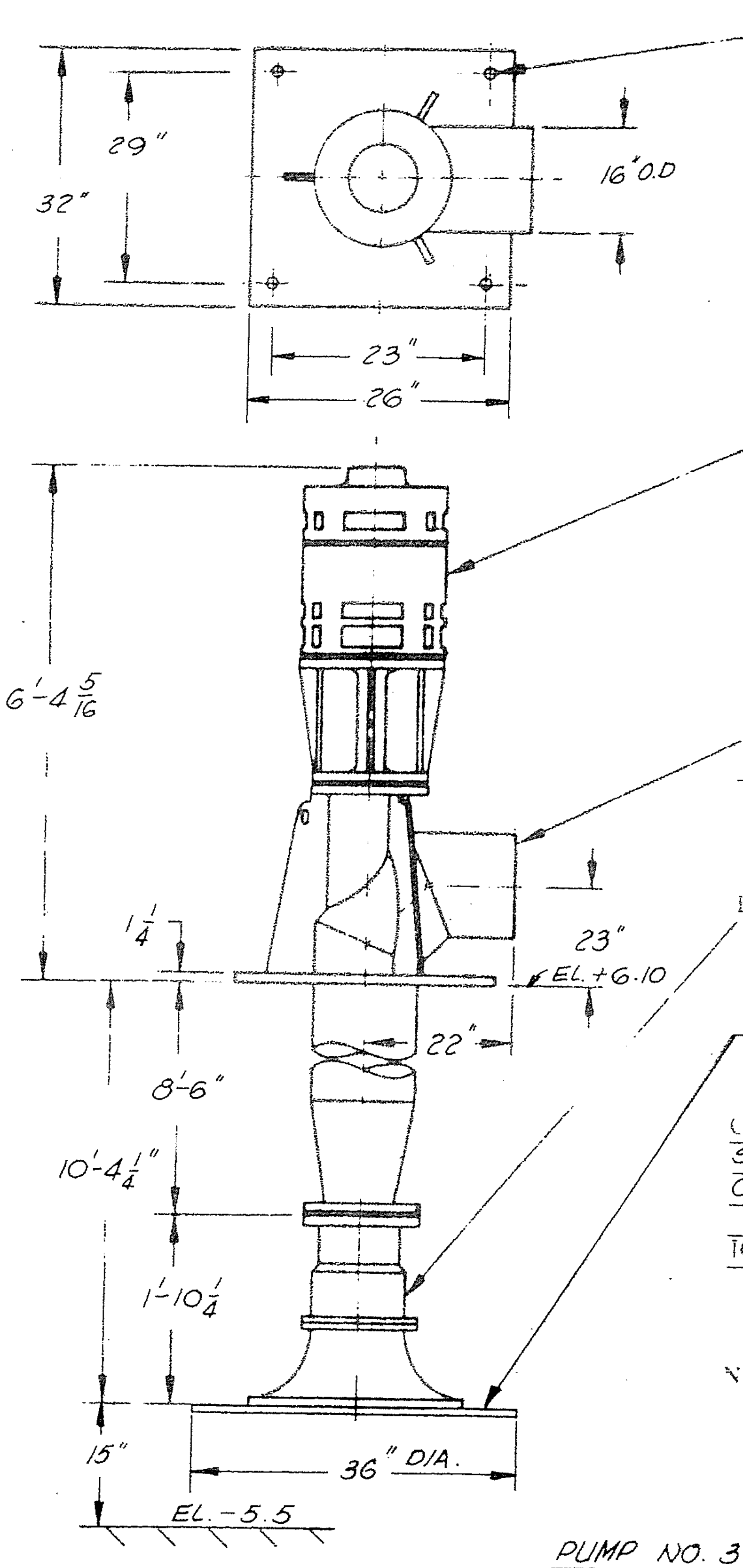
VERTICAL PUMPS

GLENDORA · CALIFORNIA · U. S. A.

PROPELLER PERFORMANCE
1 STAGE 14 PO. PUMP
1175 R.P.M.

JP-319-3M

JOHNSTON VERTICAL PROPELLER PUMP



CONDITIONS
U.S. GALLONS PER MINUTE 5500
TOTAL DYNAMIC HEAD IN FT. 16.5

GENERAL ELECTRIC - HIGH THRUST
VERTICAL HOLLOW SHAFT MOTOR
HP— 25 PHASE— 3 CYCLE— 60
VOLTAGE— 230/460 RPM— 1175
ENCLOSURE— DRIPPROOF

SURFACE DISCHARGE ELBOW 16 1/2 x 16"
1 1/2 x 1" TUBE & SHAFT ASSEMBLY

BOWL ASSEMBLY 1 STAGE 14" PO

SUCTION UMBRELLA

CUSTOMER: SAN MATEO COUNTY
SAN BRUNO CREEK FLOOD CONTROL
CONTRACTOR: Mc. GUIRE & HESTER
PO #
JOHNSTON SERIAL NO GA-3880

NOTE: DO NOT USE FOR CONSTRUCTION
UNLESS CERTIFIED

THIS PRINT CERTIFIED CORRECT BY JOHNSTON PUMP COMPANY

Original Signed by
Per H. A. J. GREUTINK

PUMP NO. 3

M.B 7-16-68

JOHNSTON PUMP CO
GLENDORA CALIFORNIA

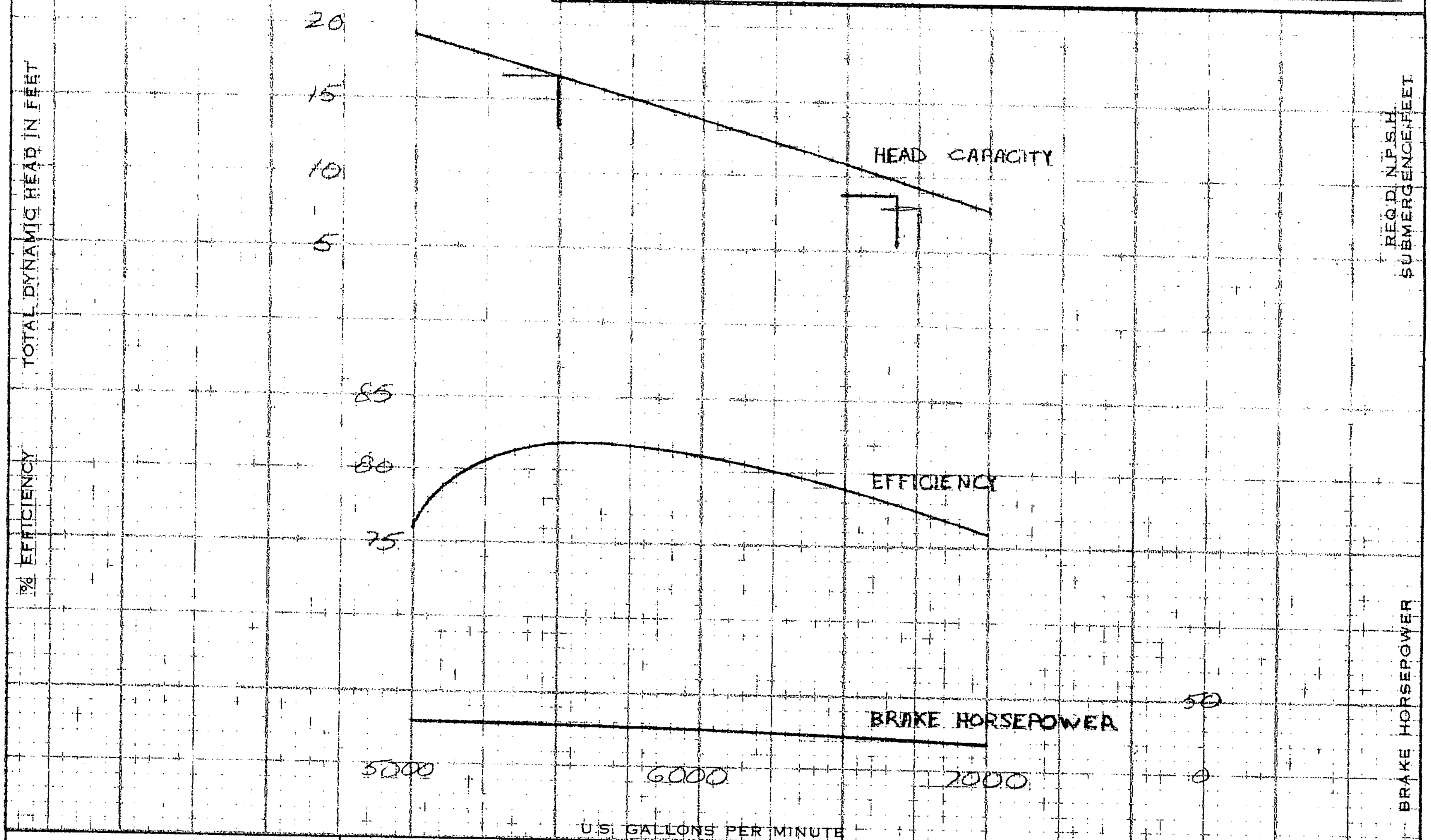
H-1600-A

NOTE: ALL COLUMN LOSSES ARE INCLUDED

JOHNSTON REF NO GA 3880

DEALER McGUIRE & HESTER REF. NO. 1896

CUSTOMER SAN BRUNO CREEK REF. NO. PUMP #3



THE CAPACITY, HEAD AND EFFICIENCY GUARANTEE IS FOR THE DESIGNATED POINT ONLY: IT IS BASED ON SHOP TESTS, WHEN HANDLING CLEAR, FRESH WATER AT A TEMPERATURE OF NOT OVER 85° F. AND UNDER SUCTION CONDITIONS AS SPECIFIED IN THE CONTRACT.

IMPELLER ______ DIA. ______

BOWLS ______

LIQUID WATER

SP. GR. 1.0

DATE 7/23/68 DS

JOHNSTON PUMP CO.

VERTICAL PUMPS

GLENDORA · CALIFORNIA · U. S. A.

PROPELLER PERFORMANCE

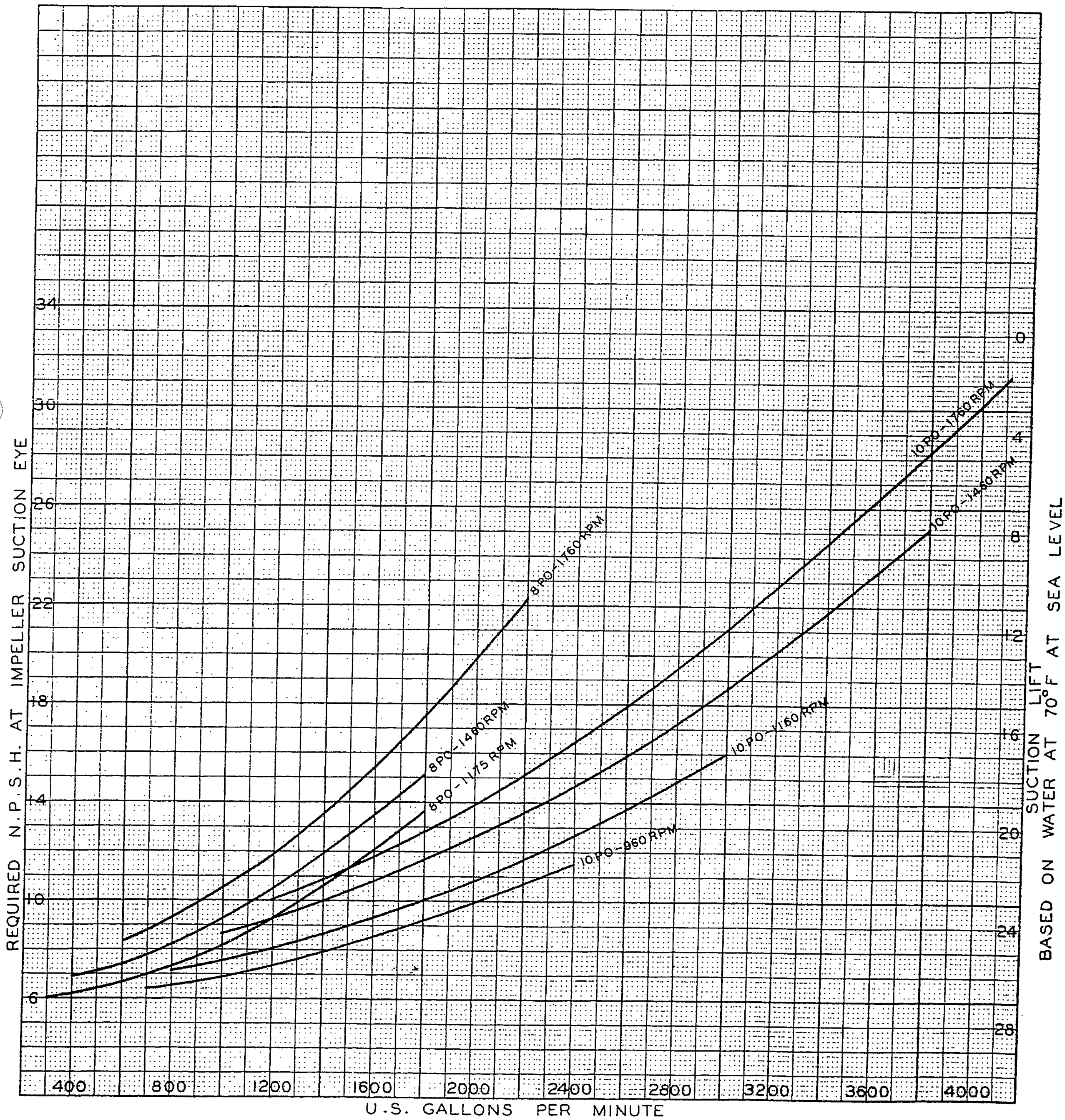
1 STAGE 14 P.O PUMP

1175 R.P.M.

JP-319-3M

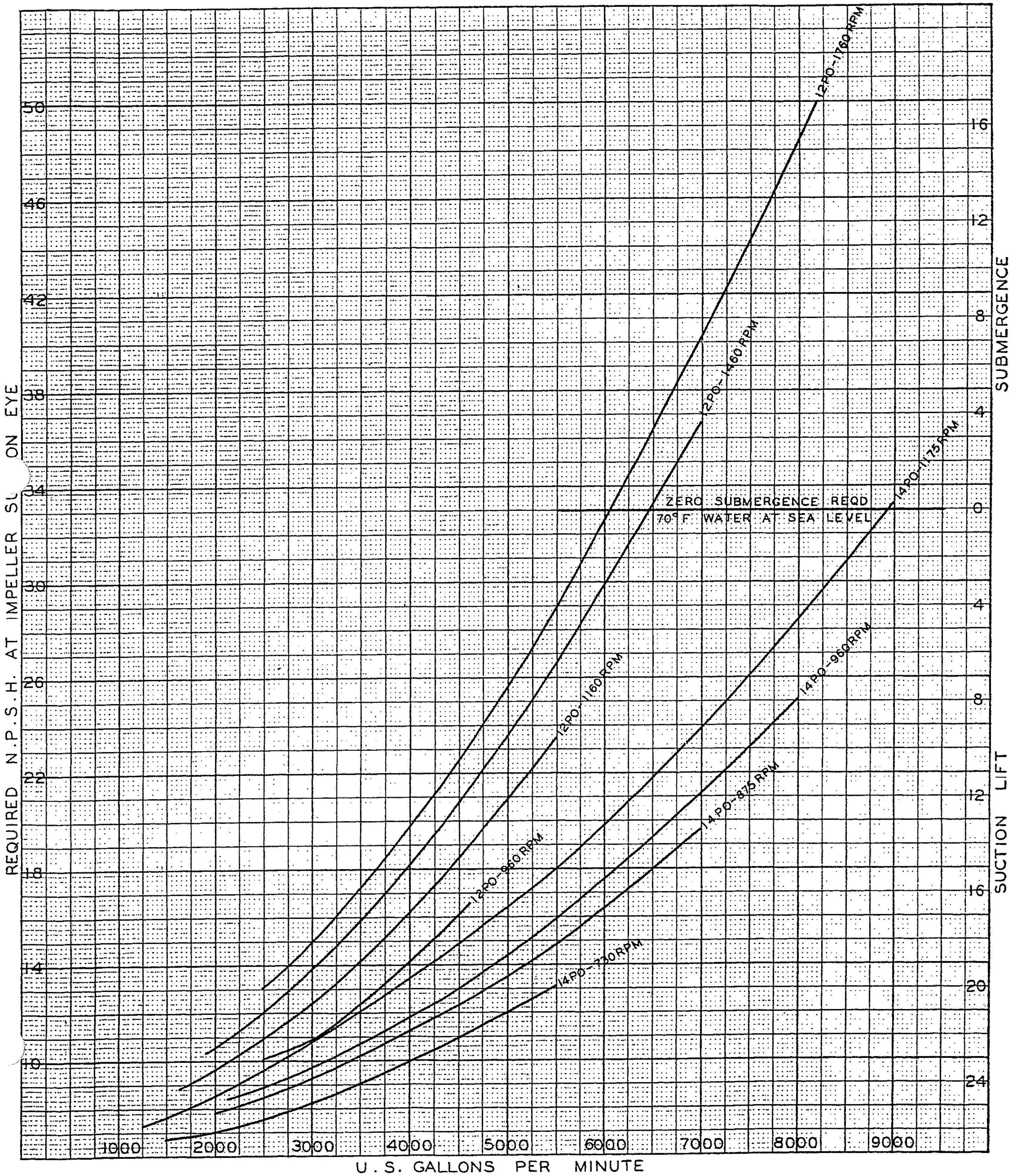
Johnston Pump Company
Brookshire, Texas 77423
ESTABLISHED 1909

PROPELLER PUMPS
NET POSITIVE SUCTION HEAD REQUIREMENT



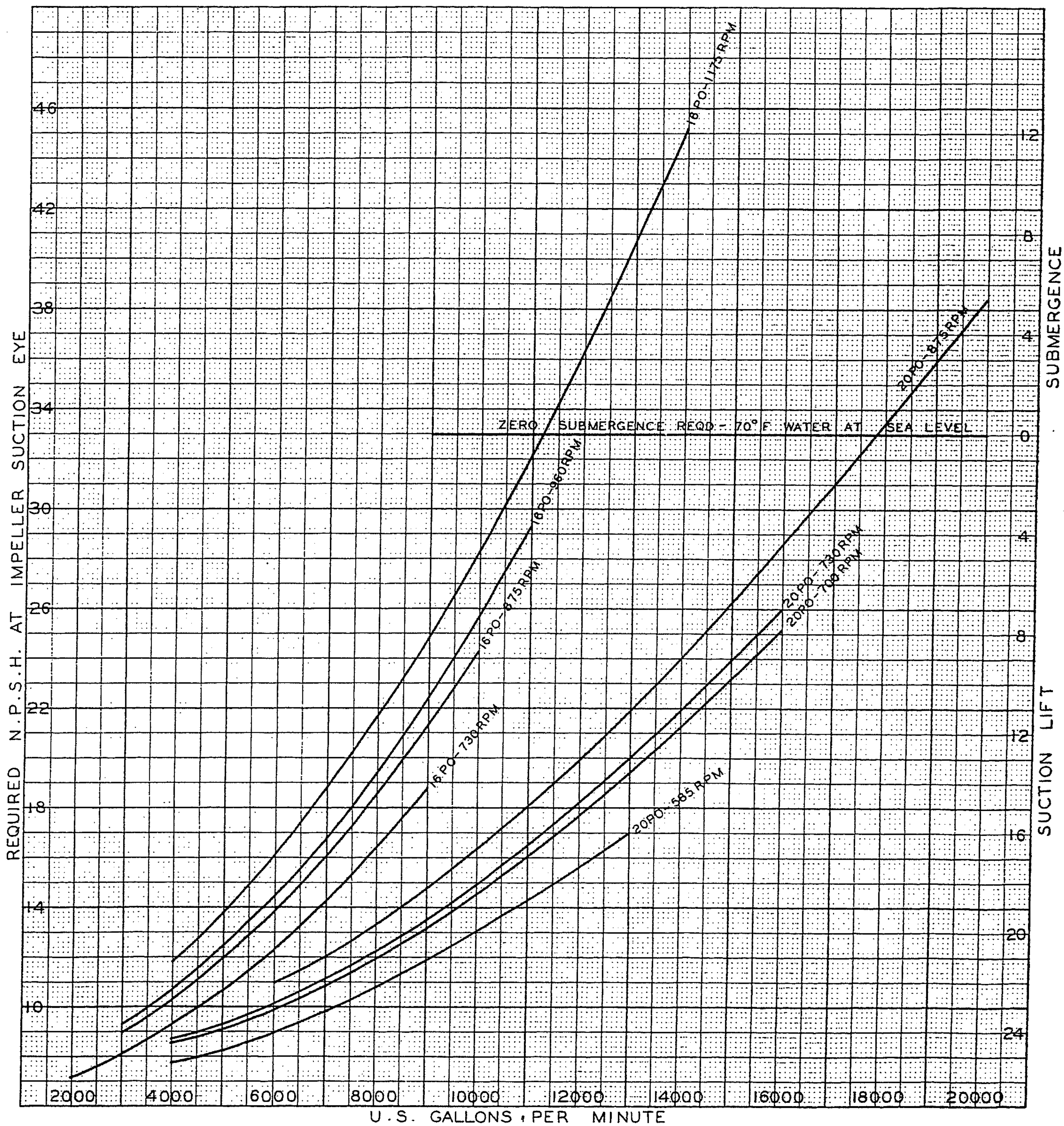
Johnston Pump Company
Brookshire, Texas 77423
ESTABLISHED 1909

PROPELLER PUMPS
NET POSITIVE SUCTION HEAD REQUIREMENT



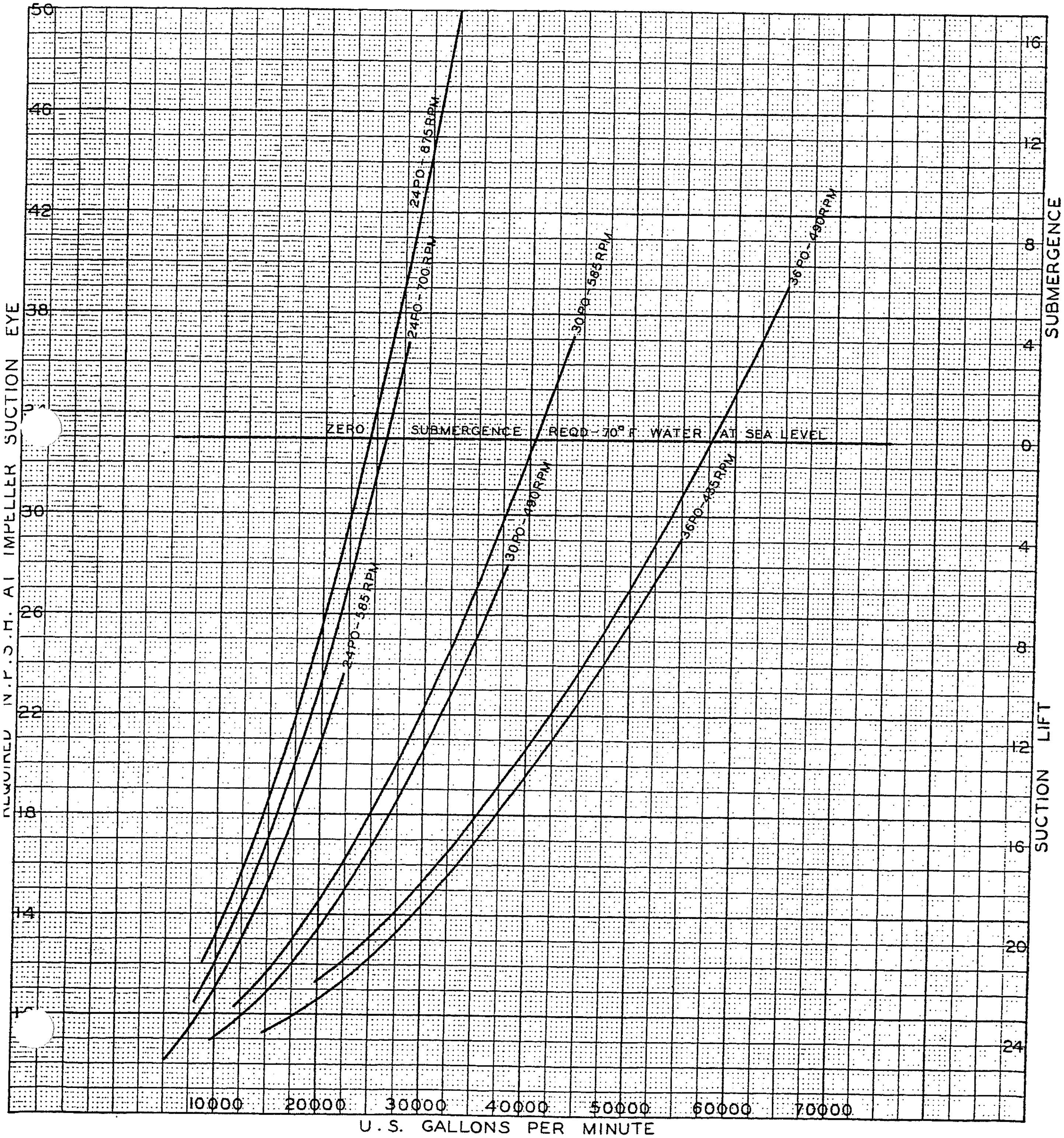
Johnston Pump Company
Brookshire, Texas 77423
ESTABLISHED 1909

PROPELLER PUMPS
NET POSITIVE SUCTION HEAD REQUIREMENT



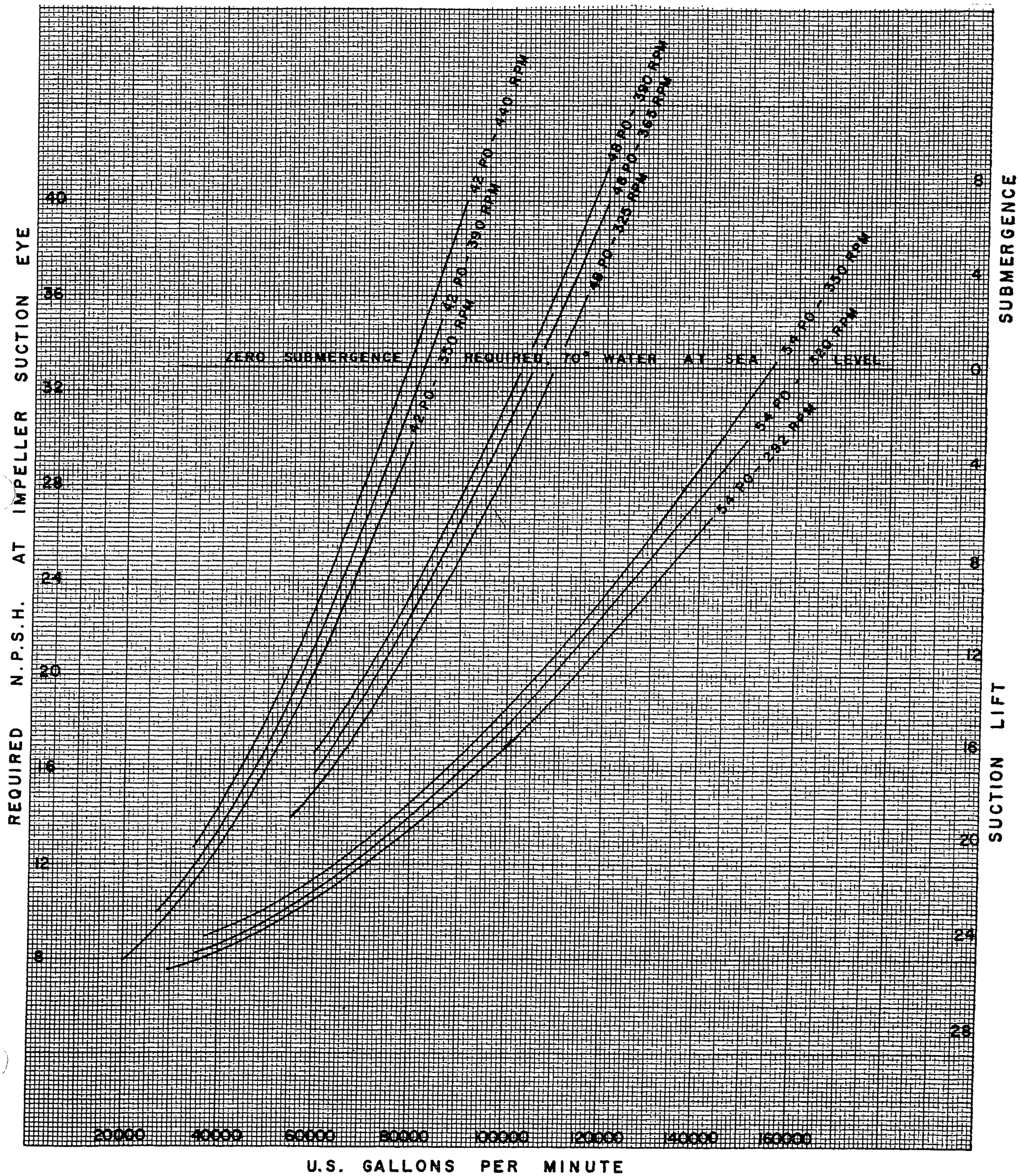
Johnston Pump Company
Brookshire, Texas 77423
ESTABLISHED 1909

PROPELLER PUMPS
NET POSITIVE SUCTION HEAD REQUIREMENT



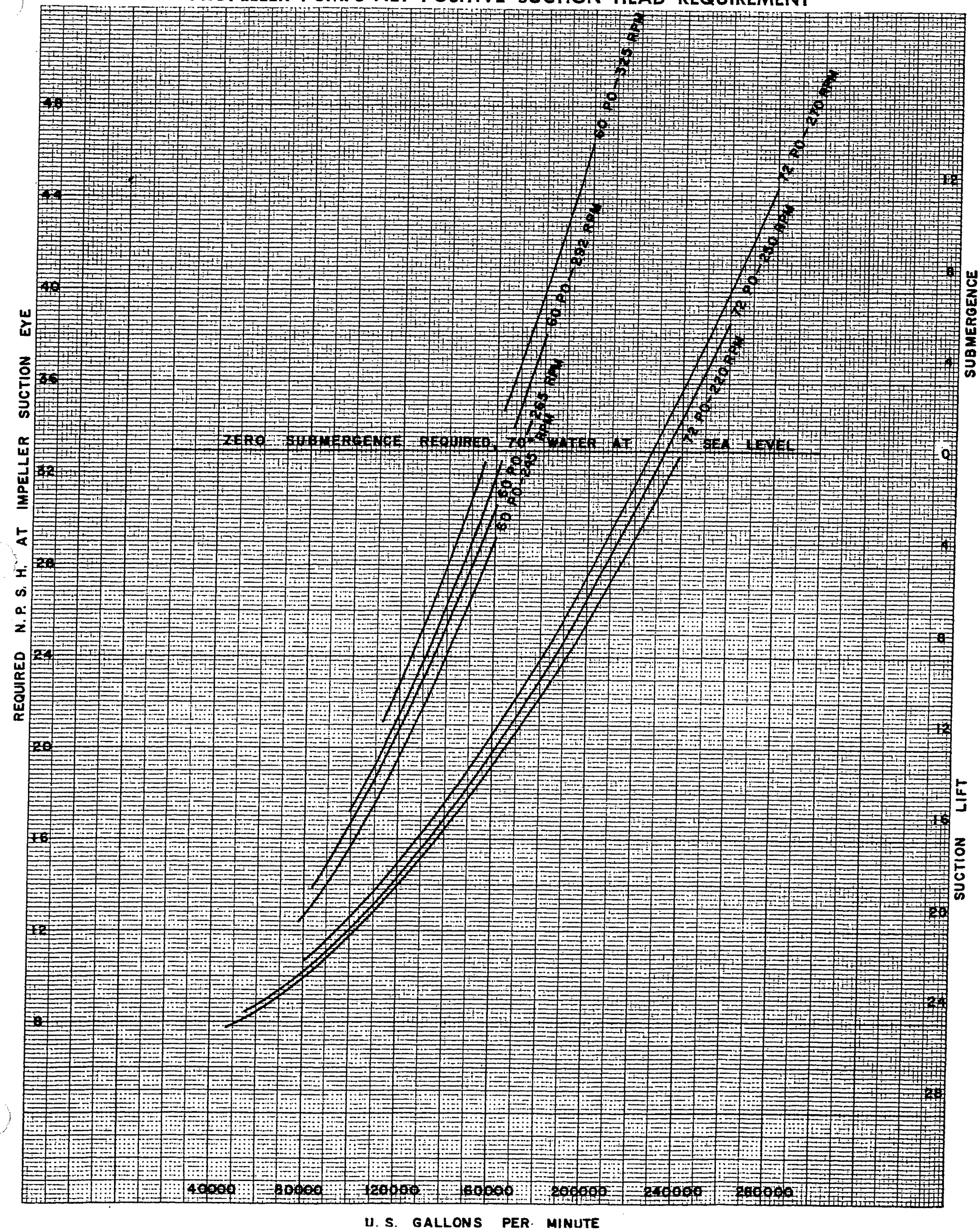
Johnston Pump Company
Brookshire, Texas 77423
ESTABLISHED 1909

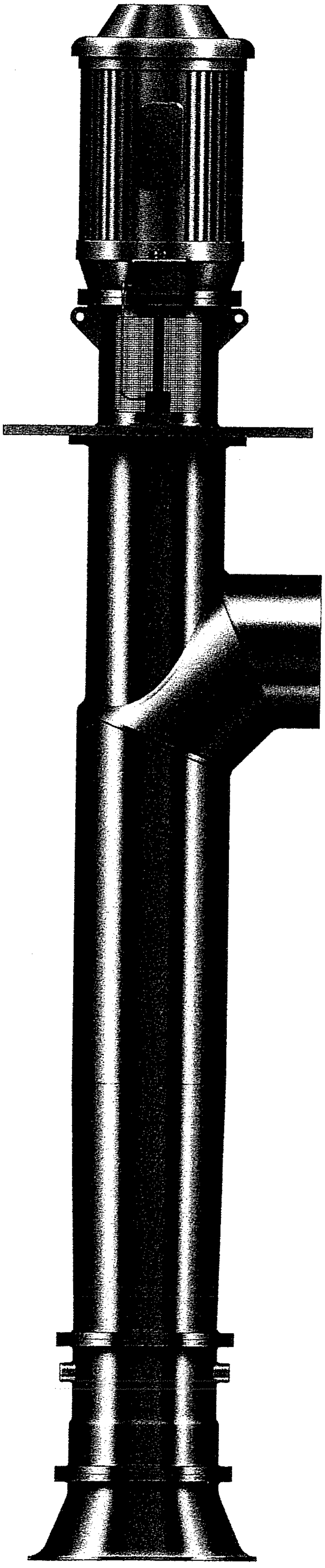
PROPELLER PUMPS
NET POSITIVE SUCTION HEAD REQUIREMENT



Johnston Pump Company
Brookshire, Texas 77423
ESTABLISHED 1909

PROPELLER PUMPS NET POSITIVE SUCTION HEAD REQUIREMENT





The Vertical Type JP Propeller

FROM THE VERTICAL PUMP SPECIALISTS

Johnston Pump

Johnston Pump Vertical Type JP
Propeller

DRIVER: The propeller pump maybe driven by electric motors (hollow and solid shaft), fixed or variable speed drives, right angle gear drives or steam turbine driven. Johnston provided drives are designed to carry the weight of all rotating parts and thrust loads meeting rigid construction requirements while providing satisfactory operation. A steady bushing is required for hollow shaft motors allowing bearing support.

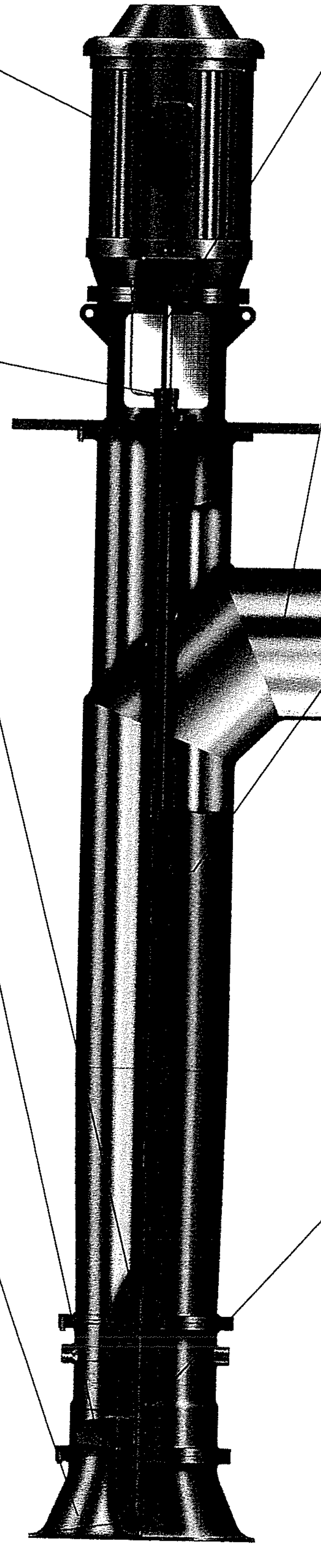
SEAL: Available seal constructions are provided for various types of service:
1) Packing box for general service (Product Lube).
2) Shaft tube for general service (Oil Lube).
3) Shaft tube water flush for (Abrasive Service).
4) Grease lubrication for (Abrasive Service).
5) Optional internal, external, balanced and non-balanced mechanical seals.

PUMPSHAFT: The shaft is made of high tensile, pumpshaft quality material in 416SS and is sized to operate without objectionable distortion or vibration in both the forward and reverse direction of rotation. Horsepower rating, straightness and machining tolerances conform to ANSI Spec. B58.1 and AWWA Specification E101 Standards.

PROPELLERS: Heavy duty cast aluminum bronze (other materials available) propellers are balanced to assure vibration free operation and hand-finished for maximum performance. The propeller, secured to the shaft by a collet or a simple key, split thrust ring and retainer, assures positive drive and adequate locking. The axial flow propeller has a single inlet, available in numerous pitches, allowing the flow to enter axially and discharge nearly axially for maximum capacity discharge.

SUCTION BELL: Fluids enter through a flared suction bell that is reinforced by heavy vanes, lending support to the bell while guiding the liquid flow parallel to the drive shaft. As fluids travel upstream, maximum efficiency and minimal shock and entry losses are achieved. Effective Johnston strainers restrict entry of any foreign object during pump operation.

SPARE PARTS: All spare parts are available in kit form to simplify ordering, speed delivery, and minimize downtime and expense.



HEADSHAFT: The headshaft is supplied with an adjusting nut or an adjustable flanged coupling for propeller adjustment, maximizing sustained efficiency. Headshaft material is available in 416SS, 316SS, 17-4SS, Nitronic 50 or K-Monel, depending on fluid pumpage.

DISCHARGE ELBOW: Elbows are available in both the above base or below base type (as illustrated). Both styles are three-section, full diameter elbows specially designed to obtain the smoothest transition of liquid from the vertical to the horizontal plane with minimum possible losses. Johnston elbows are designed with fabricated steel plate using full-penetration welds. The discharge opening can be either plain-end or flanged, depending upon requirements. Victaulic® grooves and couplings are also available allowing flexibility in the piping system. Johnston discharge elbows are designed for maximum strength and utility, pleasing appearance and long life.

COLUMN ASSEMBLY: Consists of flanged column connections, maintaining alignment and sealing the discharge pressure as well. The pump column pipe supports the bowl assembly and provides a means of conducting the pumped liquid up to the surface and out through the head. Product lubricated column provides a steel or bronze (depending on column size) fabricated bearing retainer, supporting column and shaft alignment. Lineshaft bearings are lubricated with the pumped product and are available in a variety of materials to suit the pumping application. Oil lubricated column provides a lineshaft enclosing tube, lineshaft bearing, lineshaft and lineshaft coupling. The enclosing tube shields shaft and bearings from pumped fluid carrying lubricating oil to all lineshaft bearings, as rubber spiders, press-fitted over the shaft enclosing tube, stabilize and support the column pipe tube.

BOWLS: The propeller bowl, generally one stage, is flanged and bolted constructed for ease of assembly. Johnston discharge bowl combines the energy conversion and diffusion functions of the intermediate bowl and discharge case all in one casting (as shown). Bowl bearings are of a single type and are available in several materials extending bowl and shaft life. A replaceable, cylindrical piece (bowl liner) mounted in the discharge bowl is also available to increase bowl life.

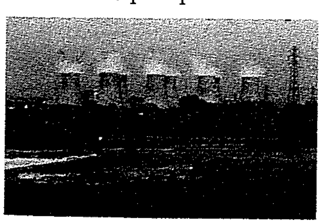
The Johnston Propeller pump, Model JP has a capacity range to 240,000GPM with total head up to 21' (single stage) in **sizes eight through seventy-two inches in bowl diameter.** Johnston Industrial Vertical Propeller (axial flow) pumps are **high-capacity, low-head units widely used** *in irrigation, drainage, flood control, condenser circulating service in nuclear or conventional power plants and numerous other applications.* Common types of fluids handled are water, chemical solutions and treated water. ***The Model JP can be manufactured from a variety of metallurgies to extend pump life and performance. Above and below base discharge connections are available suiting all available pipe designs.*** Performance and hydro testing per Hydraulic Institute Standards is optional and can be witnessed or non-witnessed, depending on customer preference. *The JP pump is engineered excellent to balance high efficiency, low submergence and NPSH consideration.*

OTHER FEATURES

• SHAFT SLEEVES • SPACER -TYPE COUPLINGS • THRUST LUGS • THRUST STUD COUPLINGS • DISCHARGE COUPLINGS • COATINGS • RENEWABLE LINERS • OVER-SIZED SOLEPLATES • SUCTION UMBRELLAS • AIR & VACUUM VALVES • LOWER INITIAL MAINTENANCE AND OPERATING COSTS • EASILY MODIFIED FOR CHANGING HYDRAULIC CONDITIONS • LOWER OPERATING SPEED • WORLD WIDE SERVICE AVAILABLE • NO MESSY, COMPLEX HYDRAULIC SYSTEM •

Applications:

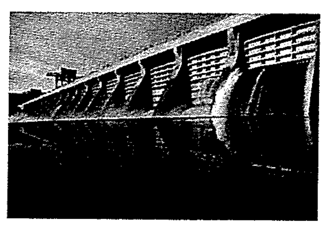
Johnston Pump has been a producer of vertical propeller (axial flow) pumps since 1909.



Today's vast capacity liquid handling problems are much more complex than those of 10 years ago. A better understanding of water pollution and application problems, increased production demands and sophisticated facility and equipment design have created the need for increase and superior high capacity-low head pumping capabilities.

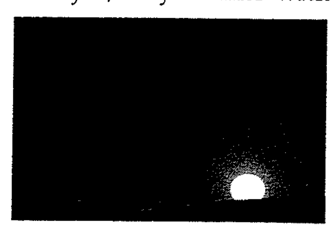
Our Model JP pump is ruggedly designed for long years of trouble free, continuous usage. The basic components of head, column pipe and bowl assembly are combined and customized to meet a large range of application conditions.

The axial (propeller) flow vertical pump mounting allows for installation with minimal floor space, flooded suctions, and minimal foundation work,



in addition to being a quiet, smooth-running, long lived pump.

Johnston Pump is one of the few manufacturers of axial flow pumps and we offer the best value for your pumping condition. We have expanded every effort to design and build axial flow pumps that run smoother, solve today's and tomorrow's liquid handling problems economically, and yet, stay in line with



competition. The propeller pump described in this article has no shortcuts and no sacrificing of quality, it just maintains its position of leadership.

Specify " Propeller" for your next installation.

Other Johnston Product Lines

FROM THE VERTICAL PUMP SPECIALISTS

- BOOSTER PUMPS
- PROPANE CAVERN PUMPS
- CARGO STRIPPER PUMPS
- MOLTEN SULPHUR PUMPS
- SEA WATER LIFT PUMPS
- FUEL TRANSFER PUMPS
- TRANSFER INJECTION PUMPS
- DEEP WELL PUMPS
- IRRIGATION PUMPS
- BOILER FEED PUMPS
- FIRE PUMPS
- LUBE AND SEAL OIL PUMPS
- BRINE TRANSFER GEOTHERMAL PUMPS
- SUBMERSIBLE PUMPS
- DRY DOCK PUMPS

JOHNSTON PUMP COMPANY

Headquarters

Brookshire
800 Koomey Road
Brookshire, Texas 77423
Phone: (713)934-6009
Fax: (713)934-6056
Toll free 1-800-926-6688

Parts & Service
Factory Service Centers

Chattanooga
2601 East 34th Street
Chattanooga, Tennessee 37407
Phone: (423)629-1415
Fax: (423)698-1447

Hampton
2305 56th Street
Hampton, Virginia 23661
Phone: (804)827-8720
Toll Free: 1-800-765-8720
Fax: (804)827-0114

Houston
6455 Burlington North
Houston, Texas 77092
Phone: (713)462-6002
Fax: (713)462-0049

Mobile
1944 South Broad Street
Mobile, Alabama 36605
Phone: (334)432-1731
Fax: (334)433-3093

Oakland
845 92nd Avenue
Oakland, California 94603
(510) 639-3200
Fax: (510) 639-3337

Pomona
3215 Producer Way
Pomona, California 91768
Phone: (909)594-9959
Fax: (909)594-2609

Portland
2251 N.W. 30th
Portland, Oregon 97208
(503) 224-6330
Fax: (503) 241-0399

Salt Lake City
3618 West 1820 South
Salt Lake City, Utah 84104
Phone: (801)973-9508
Fax: (801)973-4574

Seattle
3215 South 116th Street
Seattle, Washington 98168
(206) 433-2600
Fax: (206) 433-0263

JP Canada
4315-72 Avenue Southeast
Calgary, Alberta T2C 2G5
Phone: (403) 236-7323
Fax: (403) 235-1223

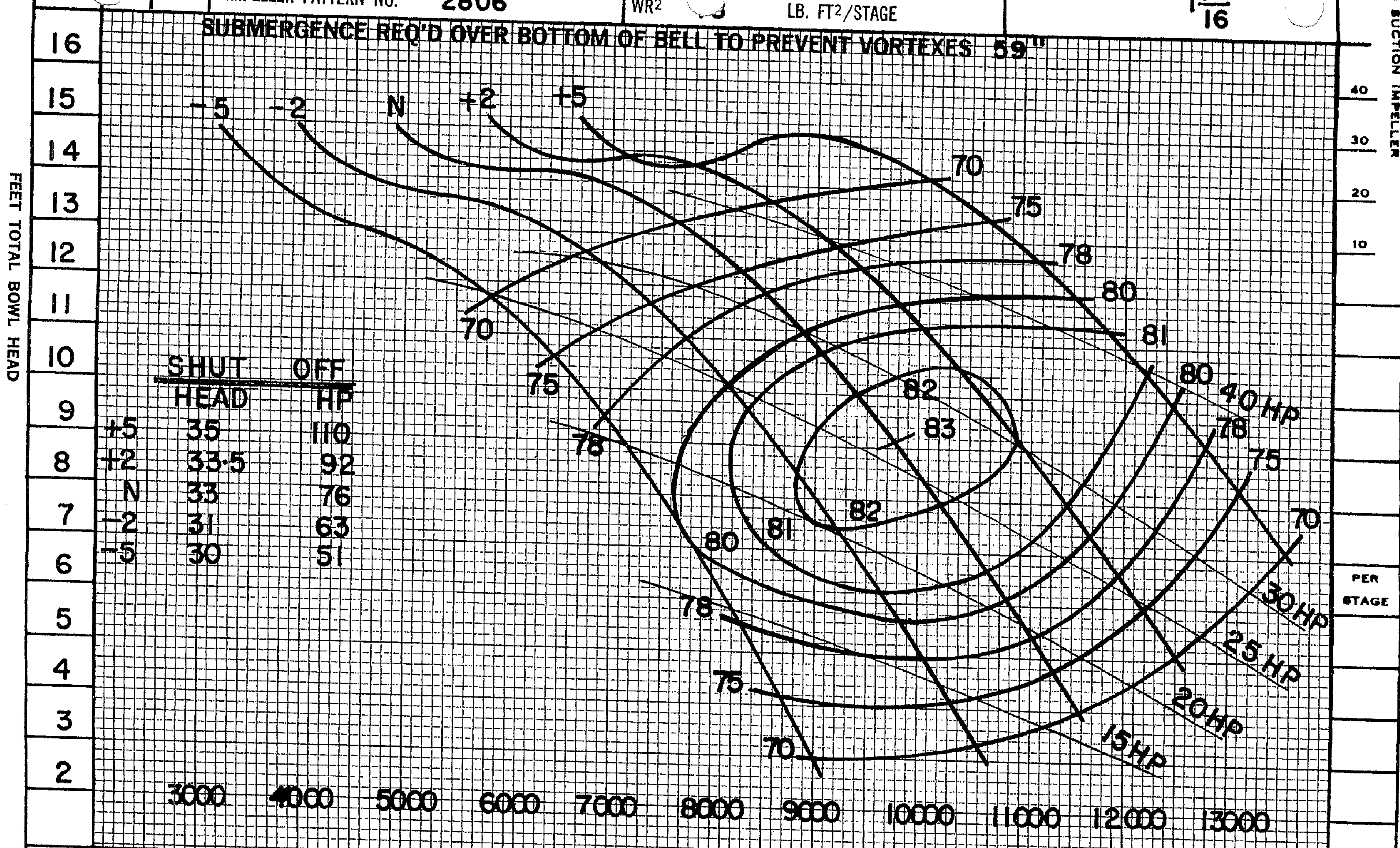
JP Canada
1907 Albion Road
Rexdale, Ontario M9W 5S8
Phone (416)675-2470
Fax: (416)675-2174

Singapore
218 Tagore Lane
Sindo Industrial Estate
Upper Thompson Road
Singapore 2678
Phone: 011-65-4582414
Fax: 011-65-4595153

Factory Parts/Service Hot Line: 1-800-765-7559 Fax: 1-800-688-2399

PER STAGE	IMP. DIA.	IMP. EXIT	IMPELLER PART NO. 2855 IMPELLER PATTERN NO. 2806	THRUST CONSTANT 135 WR2 [illegible] LB. FT2/STAGE	PUMP SHAFT DIAM. 1 15/16

SUBMERGENCE REQ'D OVER BOTTOM OF BELL TO PREVENT VORTEXES 59"



	SHUT HEAD	OFF HP
+5	35	110
+2	33.5	92
N	33	76
-2	31	63
-5	30	51

PERFORMANCE BASED ON MULTISTAGE TESTS PUMPING CLEAR COLD WATER SP. GR. 1.0

FOR 1 STAGE MULTIPLY HEAD & EFF. BY 1.0

FOR 2 STAGES MULTIPLY HD. & EFF. BY 1.0

DATE 9-25-73

Johnston Pump Company
Brookshire, Texas 77423
ESTABLISHED 1909

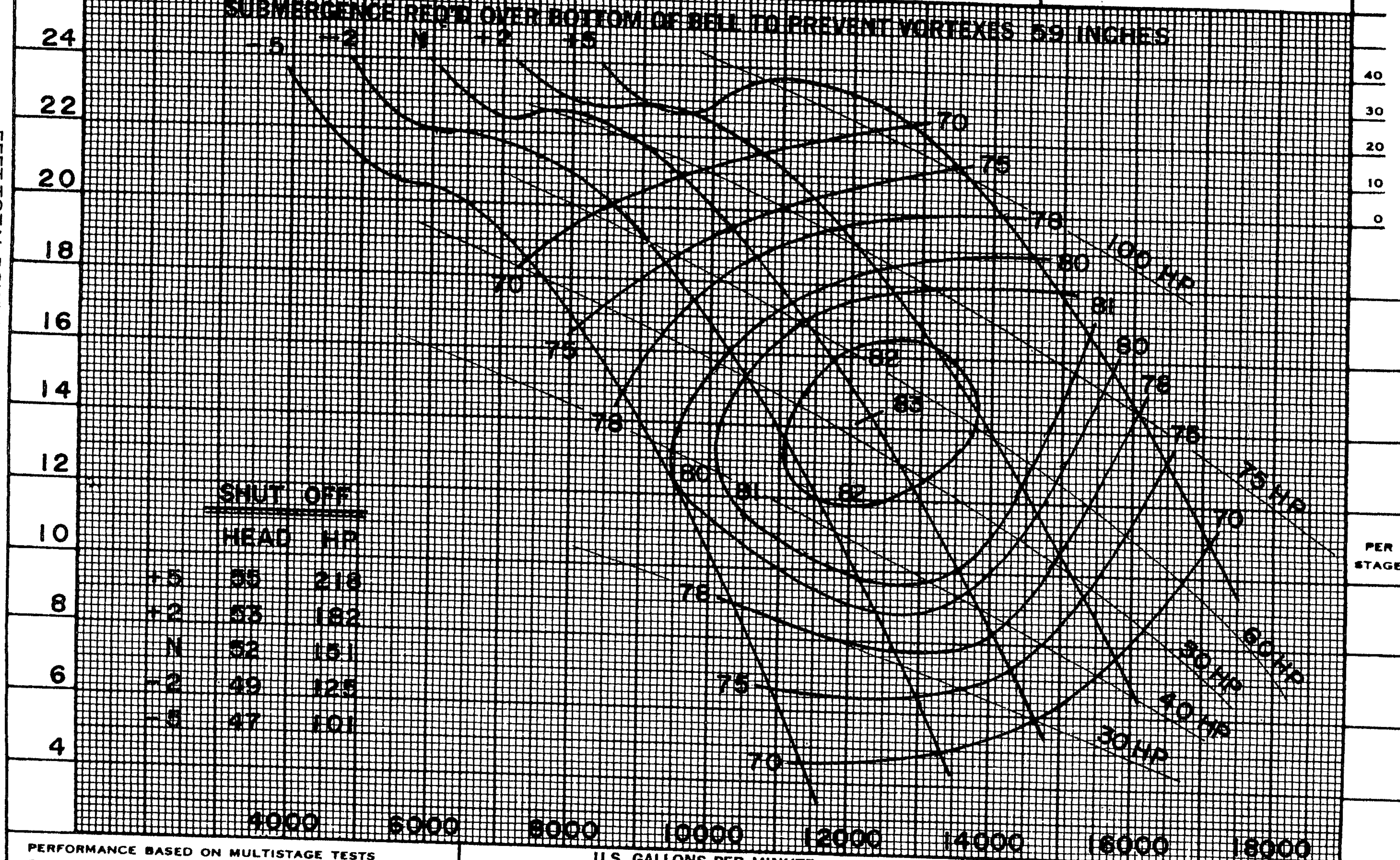
20 PO PROPELLER PUMP 700 R.P.M

IMPELLER — BRONZE BOWL — CAST IRON

CURVE SHEET NO. EC-0860

PER STAGE	IMP. DIA.	IMP. EXIT	IMPELLER PART NO. 2855 IMPELLER PATTERN NO. 2806	THRUST CONSTANT 135 WR2 18 LB. FT2/STAGE	PUMP SHAFT DIAM. 1 15/16

SUBMERGENCE REQ'D OVER BOTTOM OF BELL TO PREVENT VORTEXES 59 INCHES



SHUT OFF

	HEAD	HP
+5	55	218
+2	53	182
N	52	151
-2	49	125
-5	47	101

PERFORMANCE BASED ON MULTISTAGE TESTS
PUMPING CLEAR COLD WATER SP. GR. 1.0

FOR 1 STAGE MULTIPLY HEAD & EFF. BY 1.0

FOR 2 STAGES MULTIPLY HD. & EFF. BY 1.0

DATE 11-18-86

Johnston Pump Company
Brookshire, Texas 77423
ESTABLISHED 1909

20 PO PROPELLER PUMP 880 R.P.M

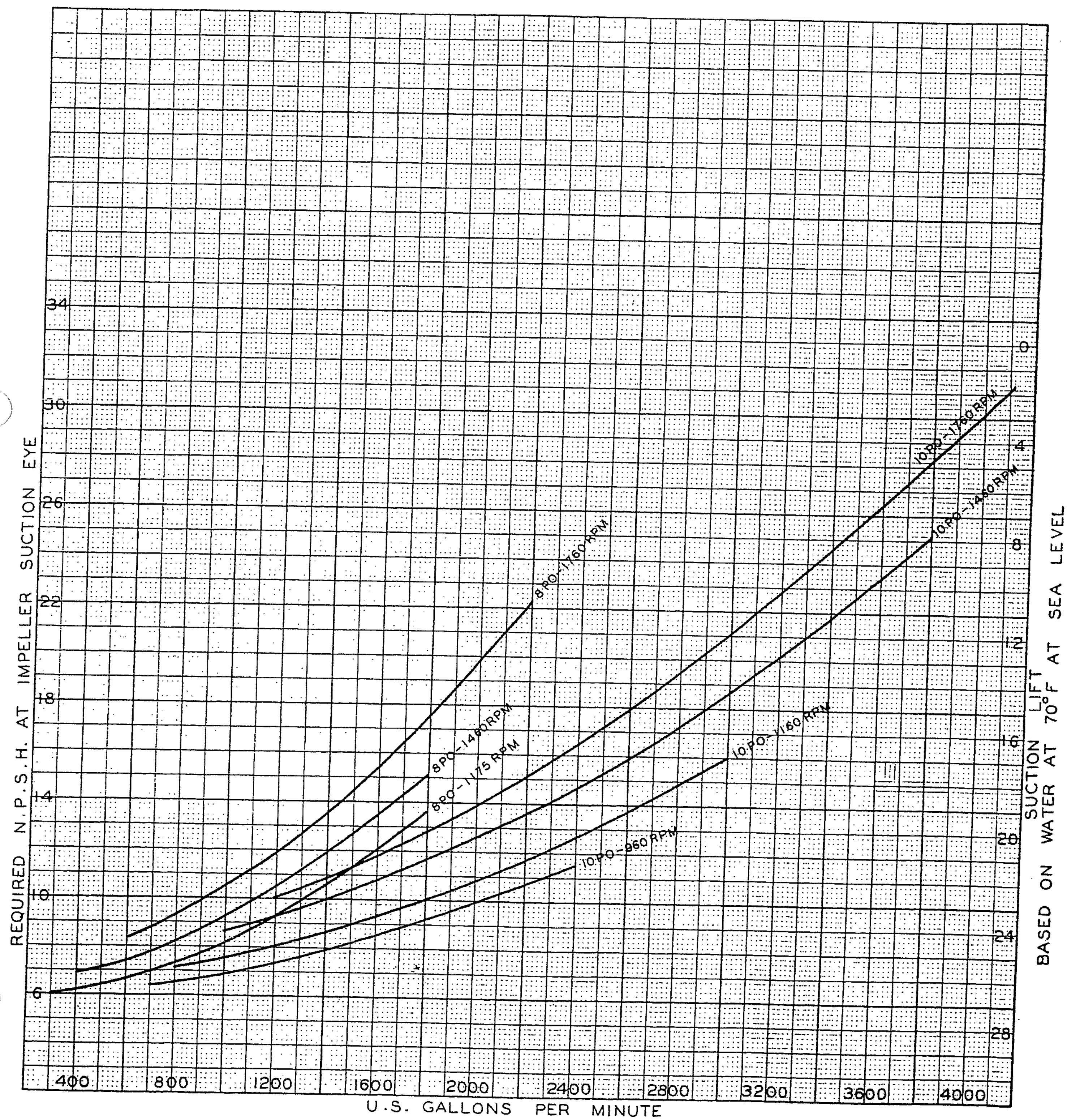
IMPELLER — BRONZE   BOWL — CAST IRON

CURVE SHEET NO. EC-0792

JP-341

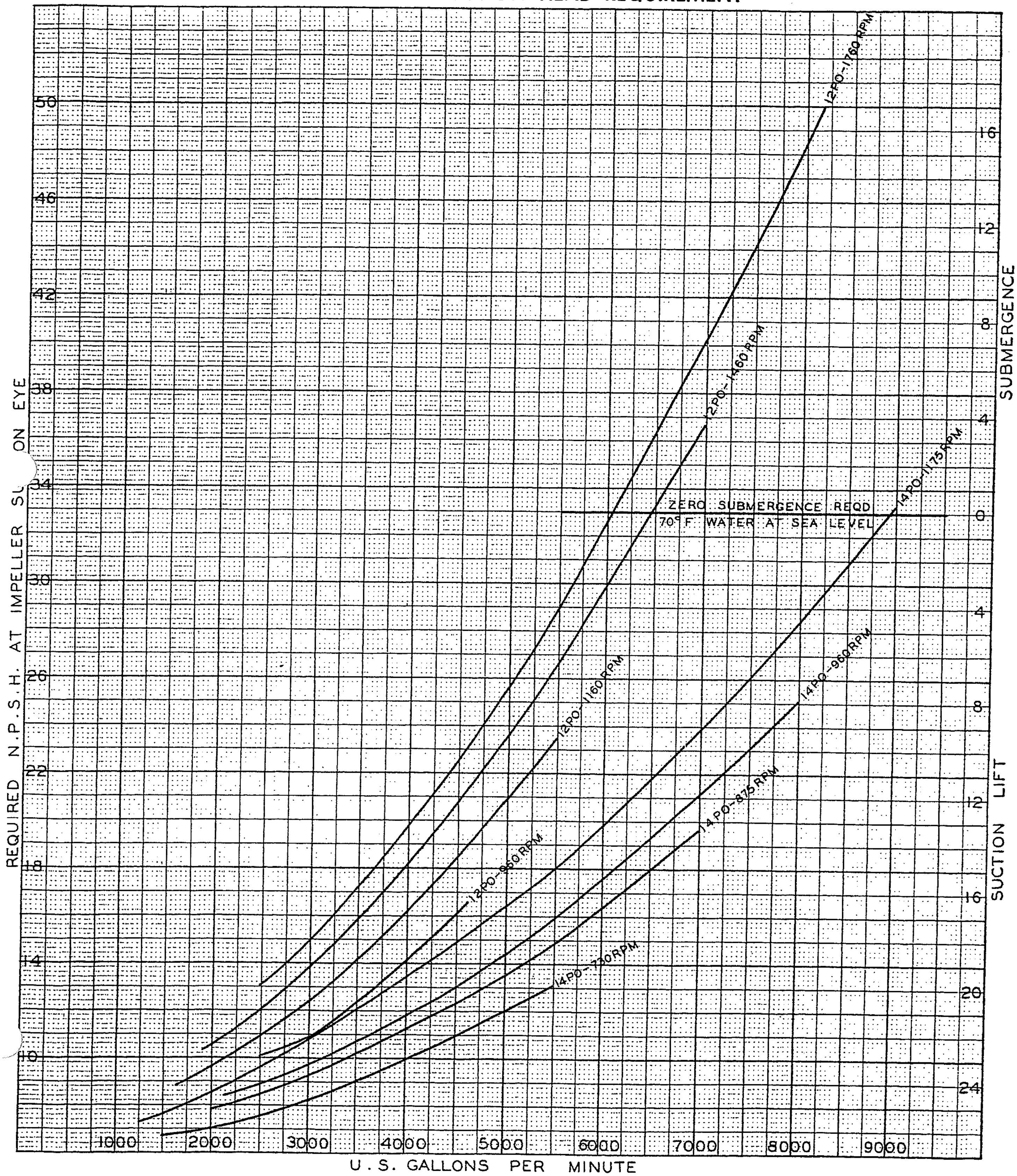
Johnston Pump Company
Brookshire, Texas 77423
ESTABLISHED 1909

PROPELLER PUMPS
NET POSITIVE SUCTION HEAD REQUIREMENT



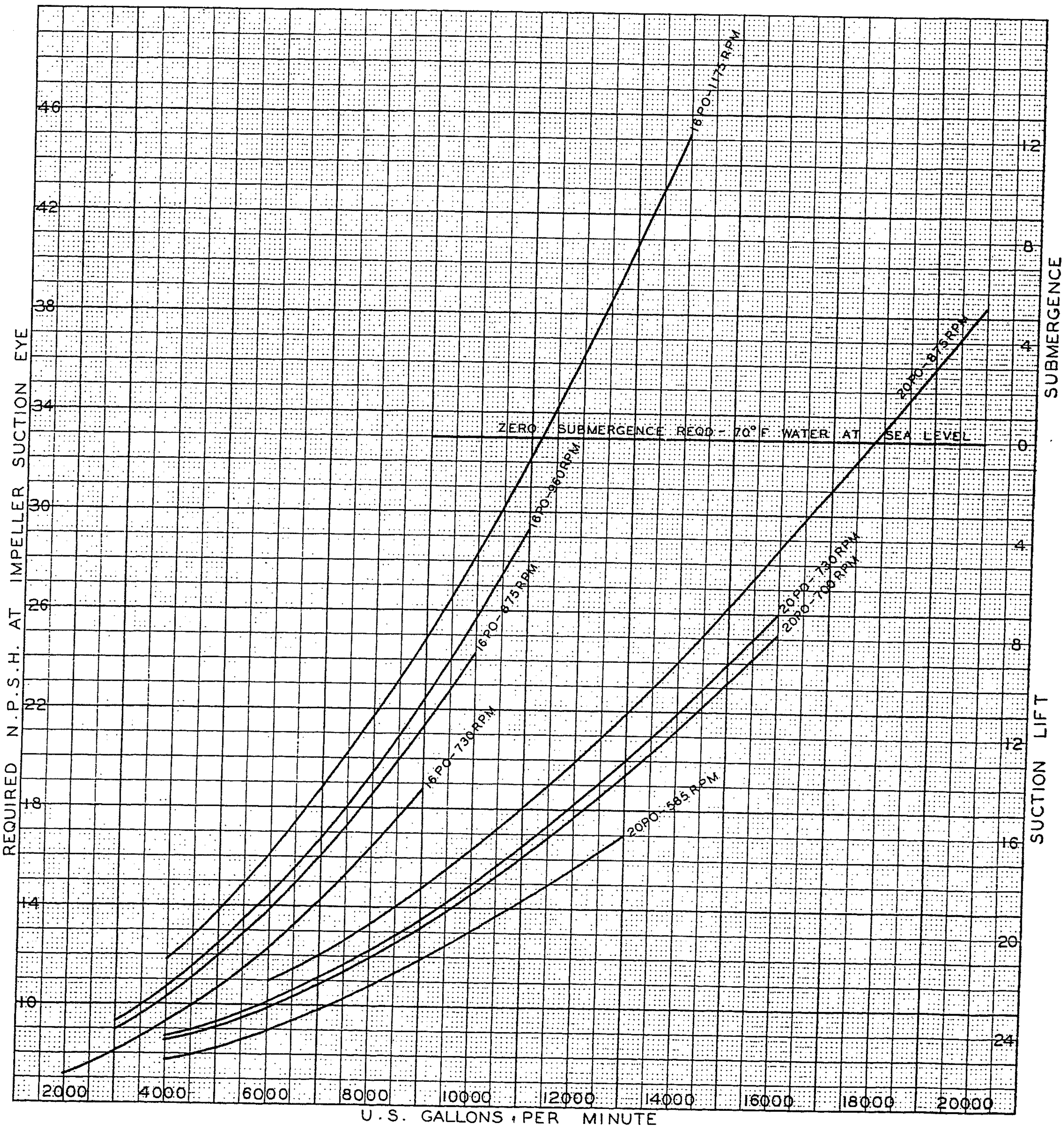
Johnston Pump Company
Brookshire, Texas 77423
ESTABLISHED 1909

PROPELLER PUMPS
NET POSITIVE SUCTION HEAD REQUIREMENT



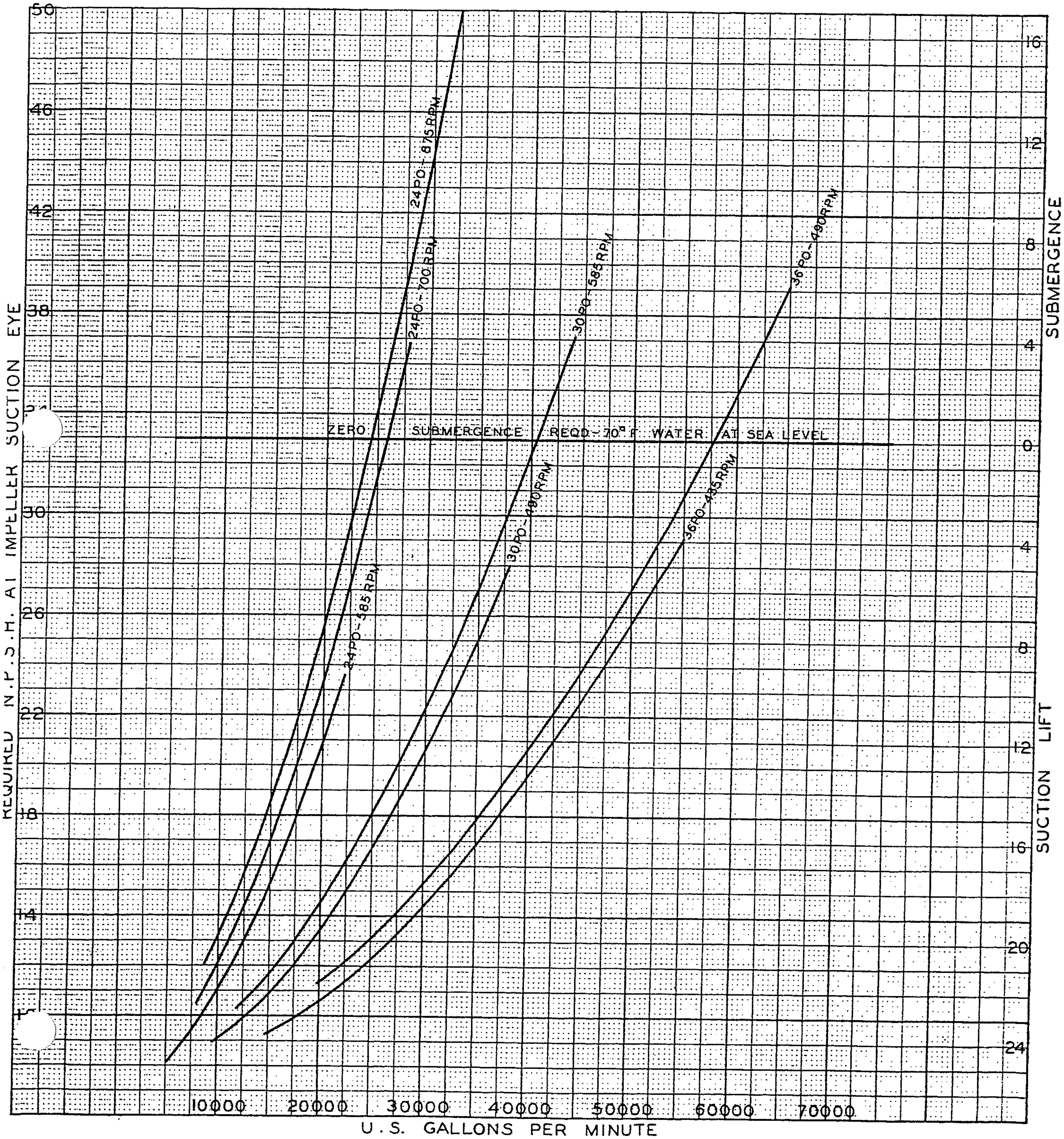
Johnston Pump Company
Brookshire, Texas 77423
ESTABLISHED 1909

PROPELLER PUMPS
NET POSITIVE SUCTION HEAD REQUIREMENT



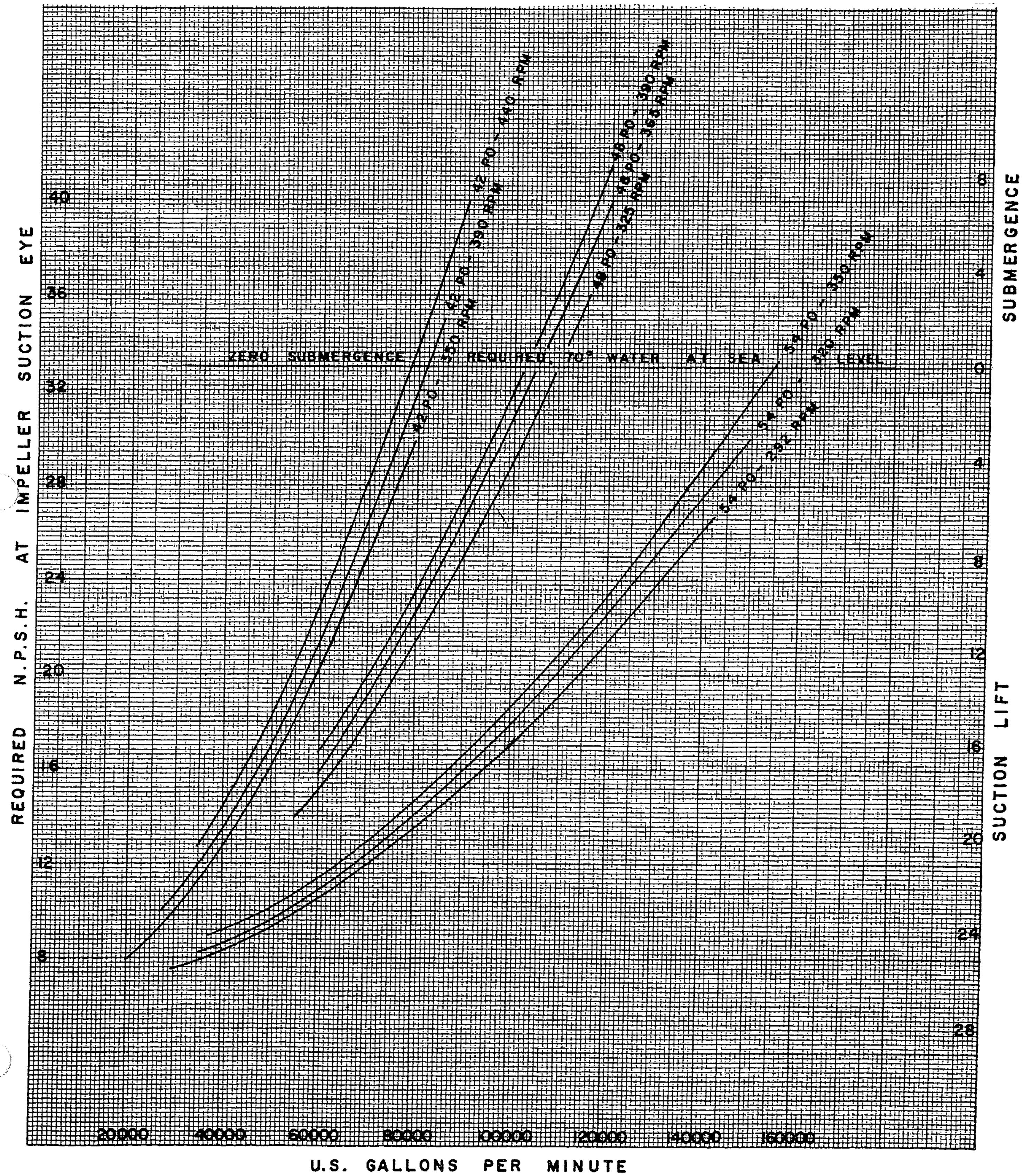
Johnston Pump Company
Brookshire, Texas 77423
ESTABLISHED 1909

PROPELLER PUMPS
NET POSITIVE SUCTION HEAD REQUIREMENT



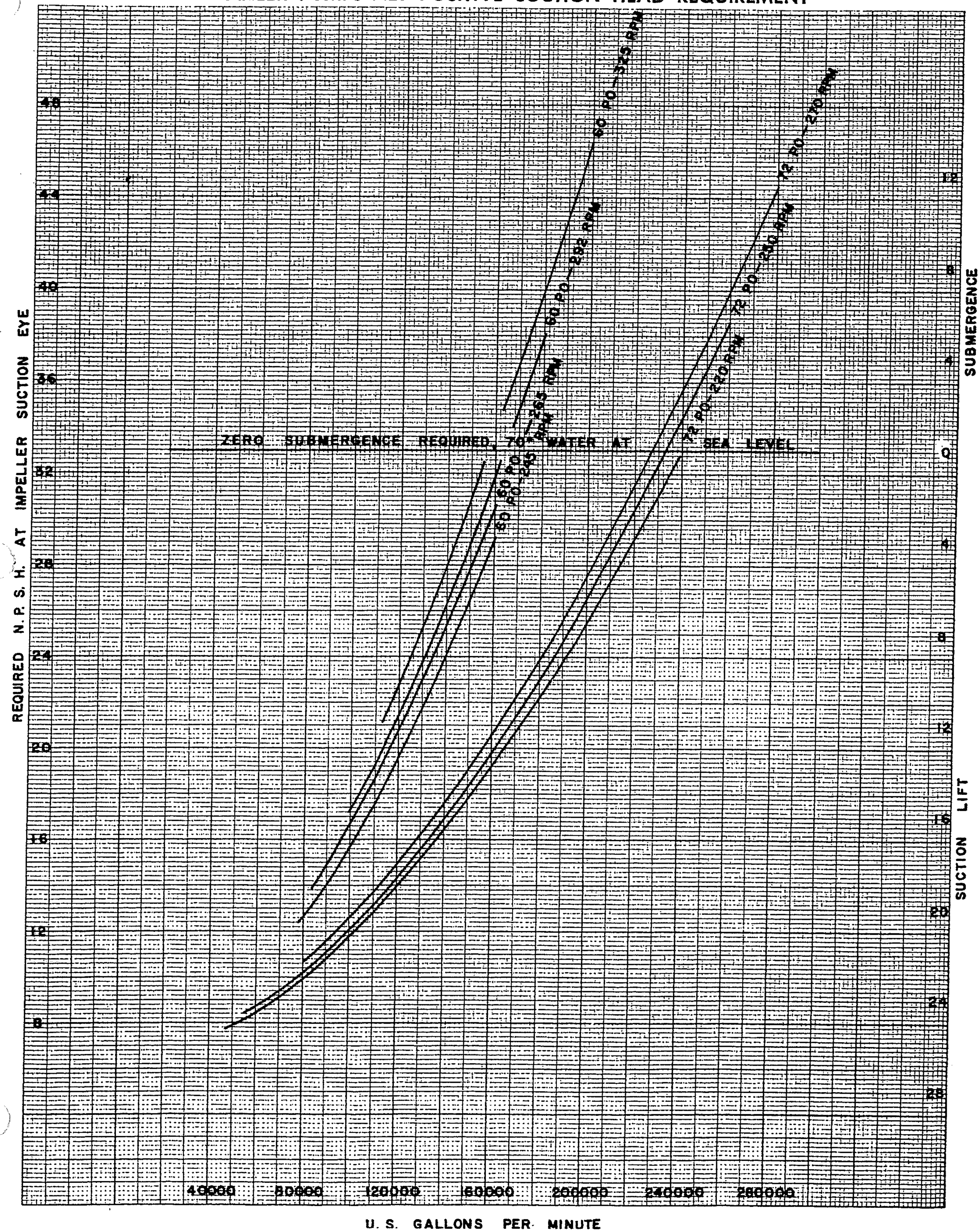
Johnston Pump Company
Brookshire, Texas 77423
ESTABLISHED 1909

PROPELLER PUMPS
NET POSITIVE SUCTION HEAD REQUIREMENT



Johnston Pump Company
Brookshire, Texas 77423
ESTABLISHED 1909

PROPELLER PUMPS NET POSITIVE SUCTION HEAD REQUIREMENT



APPENDIX B: SAN BRUNO CREEK FLOOD CONTROL PROJECT – WALNUT PUMPING STATION RENOVATION DRAWINGS DATED JULY 1997 PREPARED BY BRIAN KANGAS FOULK

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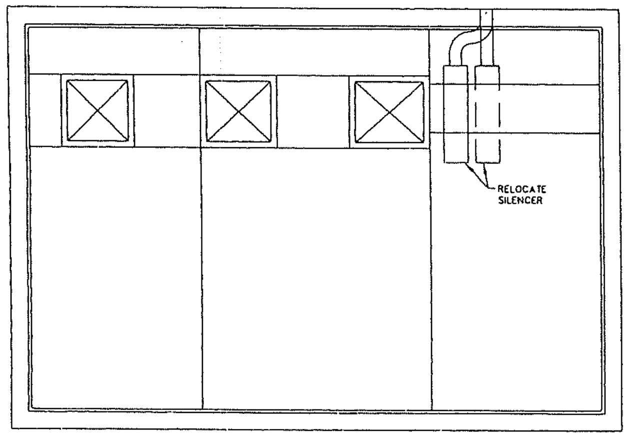
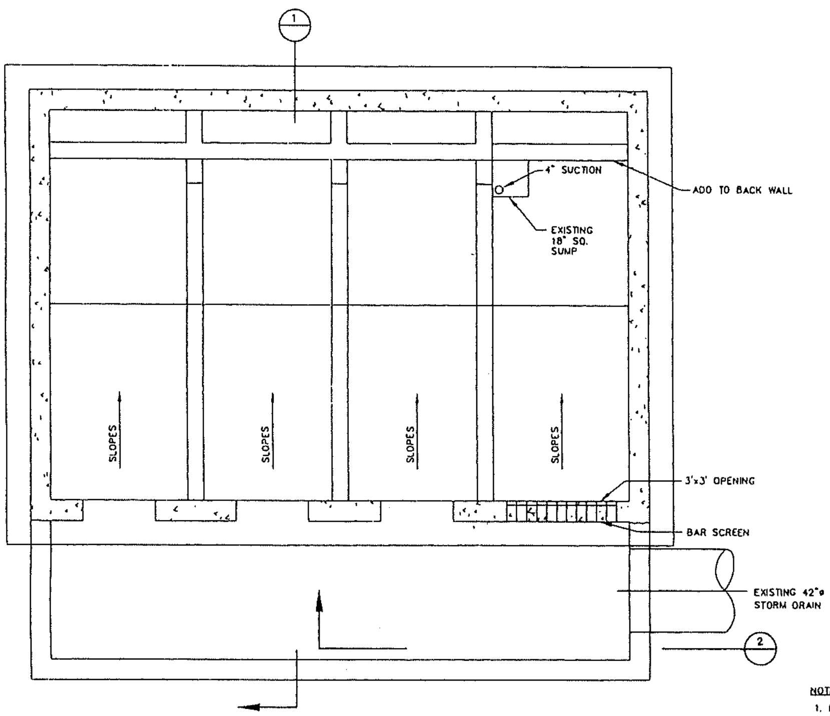


ROOF FRAMING PLAN

SCALE: 3/8"=1'-0"



PLAN ON GRADE

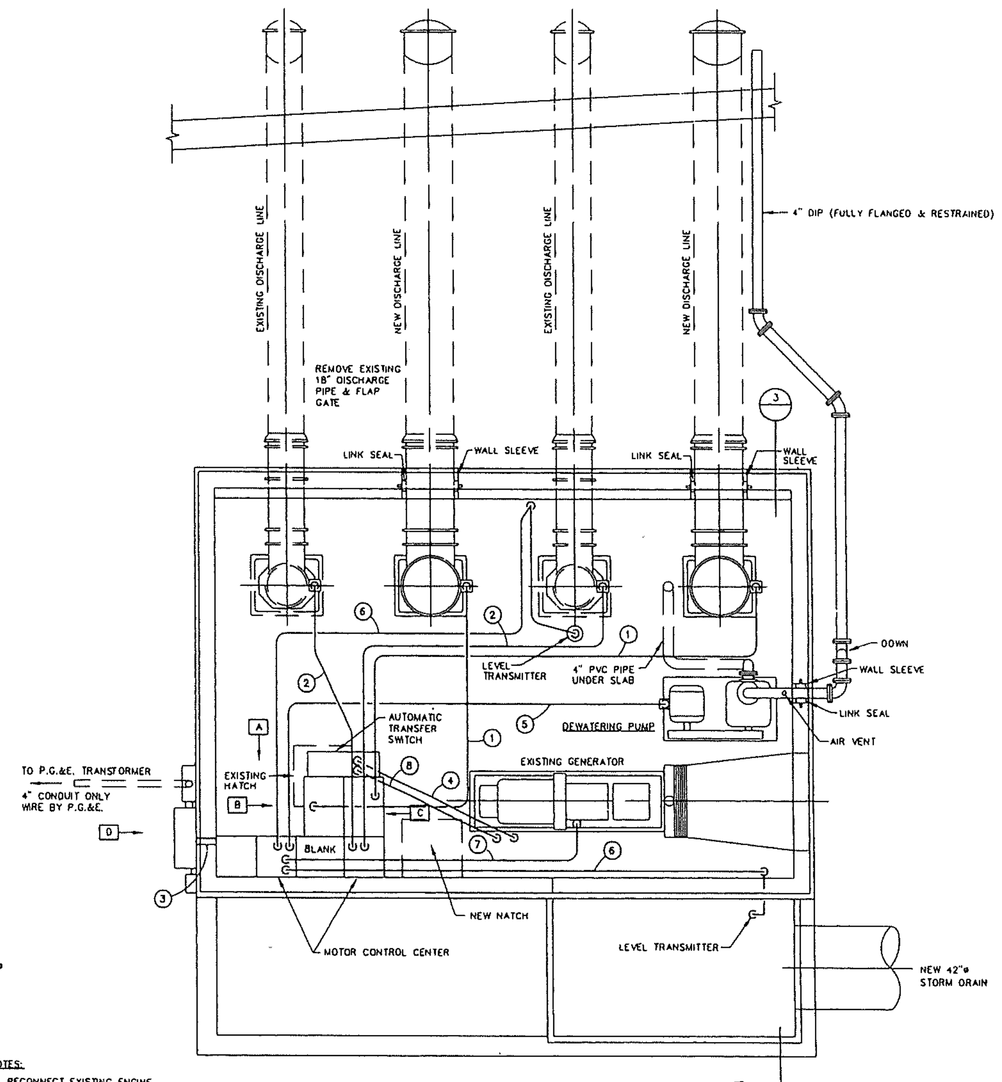
SCALE: 3/8"=1'-0"

NOTES:

1. RECONNECT EXISTING ENGINE BATTERY CHARGER.
2. RECONNECT EXISTING ENGINE J. W. HEATER.

D SECTION PER PS-2

3 NOTES PER PS-3



PLAN

SCALE: 3/8"=1'-0"

WALNUT PUMP STATION

SAN BRUNO CREEK FLOOD CONTROL PROJECT

WALNUT PUMP STATION RENOVATION

Brian Kangas Foulk

981 Ridder Park Dr. Suite 100
San Jose CA 95131

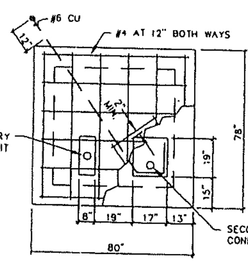
Date 8/6/97
Scale AS SHOWN

No. | Revisions

12

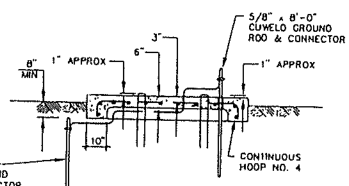
NOTE:

RUN 1-4" CONDUIT PRIMARY FROM PAD TO POLE RISER. RUN 1-4" CONDUIT TO PUMP STATION EQUIPMENT STATION ON THIS DRAWING AND IN ELEVATION [0].



NOTE:
CONSTURCT TRANSFORMER PAD IN ACCORDANCE WITH P.G.&E. DWG. NO. D45292. VERIFY DIMENSIONS.

TOP

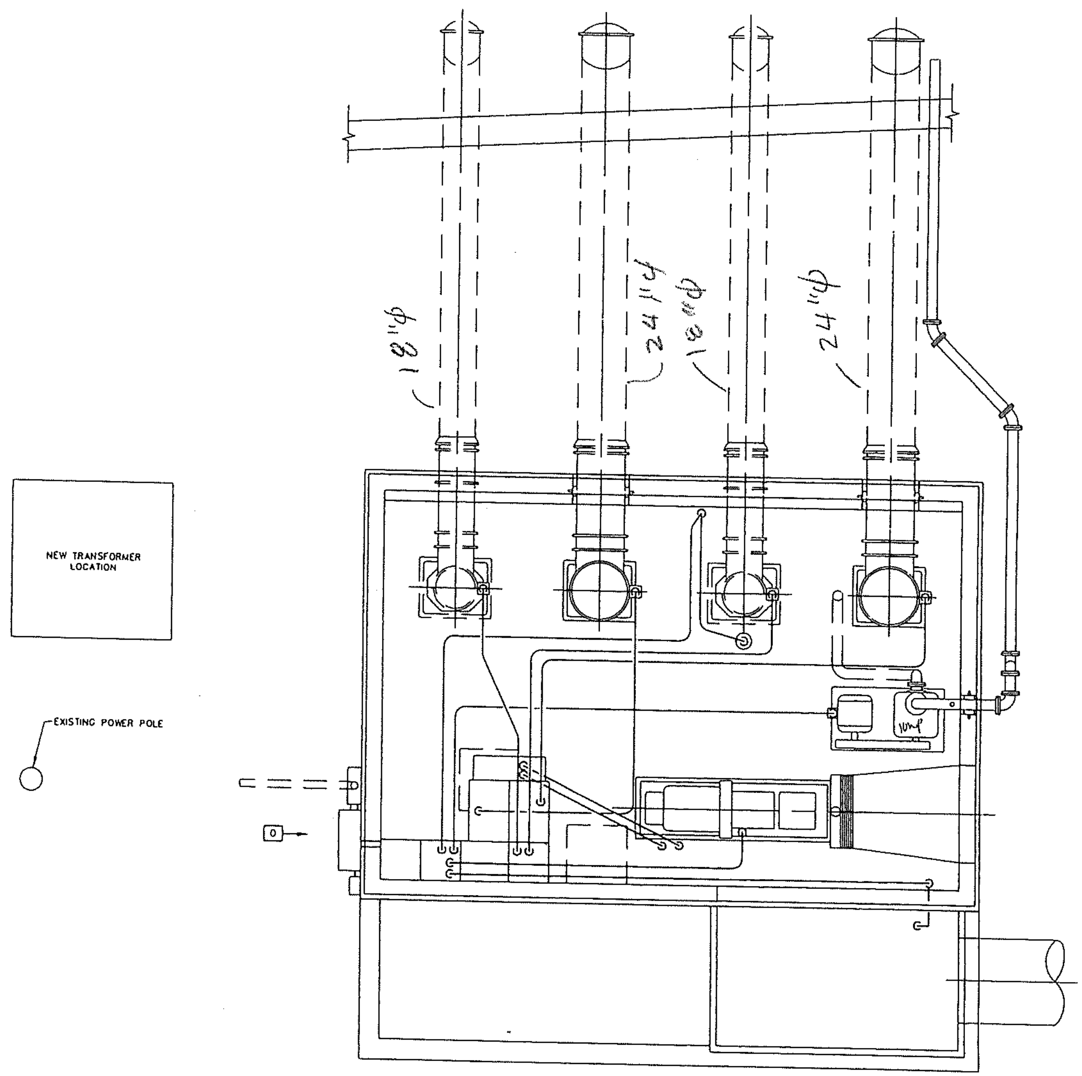


FRONT

TRANSFORMER PAD

FOR P.G.&E. TRANSFORMER

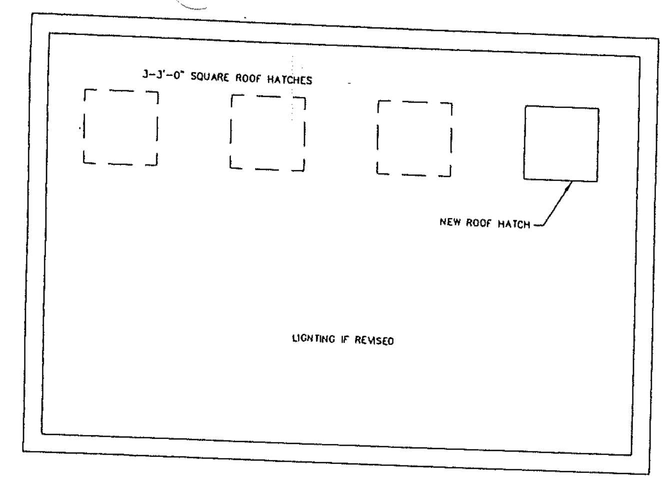
SCALE: 3/8"=1'-0"



SITE PLAN

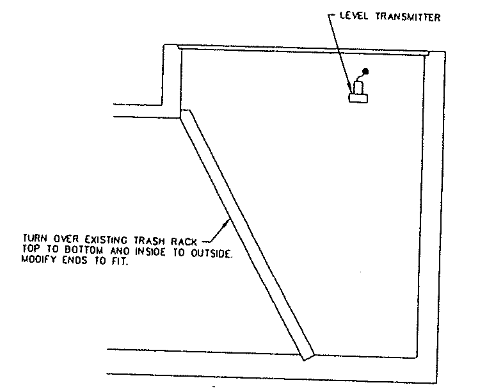
SCALE: 3/8"=1'-0"

WALNUT PUMP STATION



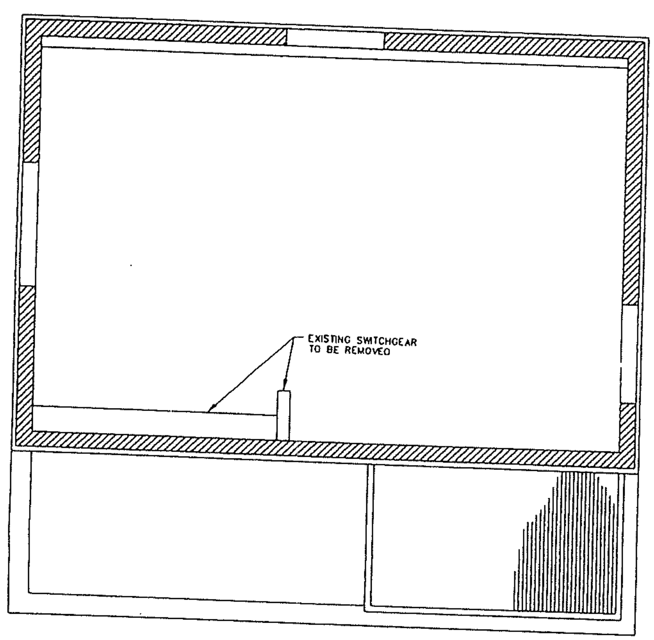
ROOF PLAN

SCALE: 3/8"=1'-0"



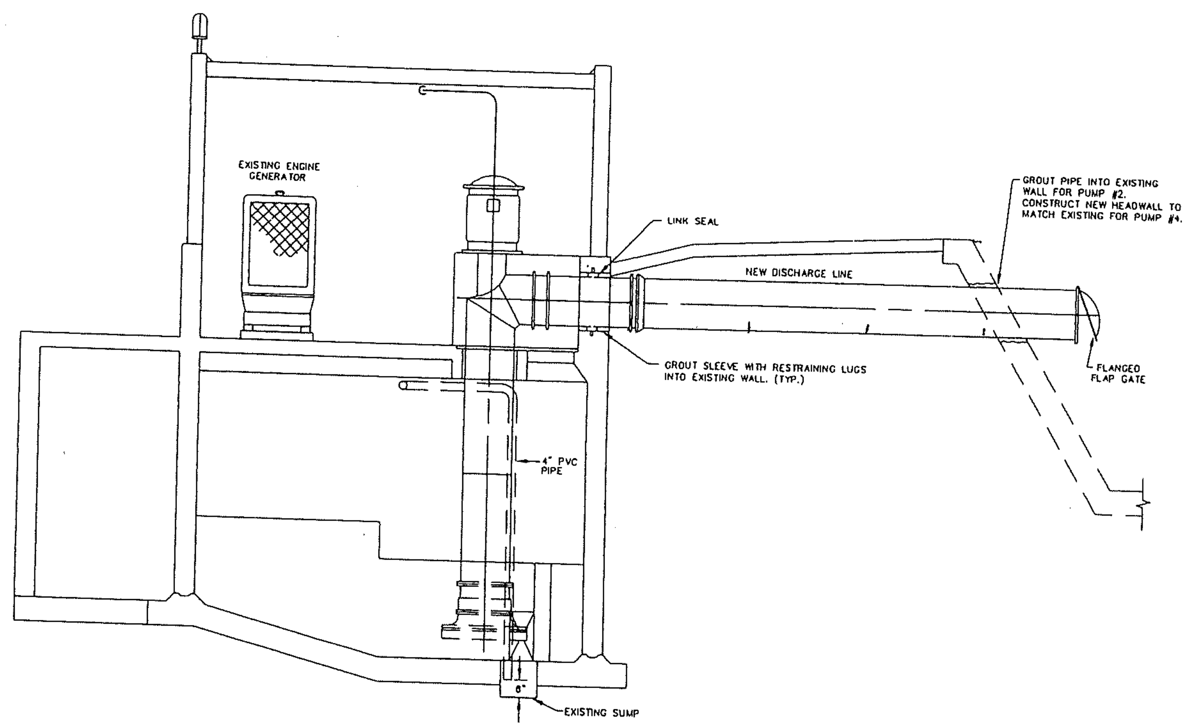
SECTION 2

SCALE: 3/8"=1'-0"



FLOOR PLAN

SCALE: 3/8"=1'-0"



SECTION 3

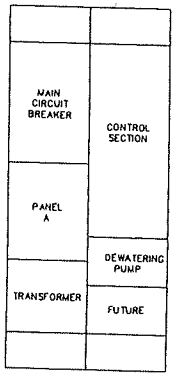
SCALE: 3/8"=1'-0"

SAN BRUNO CREEK FLOOD CONTROL PROJECT

WALNUT PUMP STATION

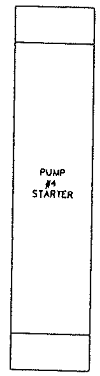
Date 6/10/97 | Scale AS SHOWN | Drawn | No. | Revisions

13



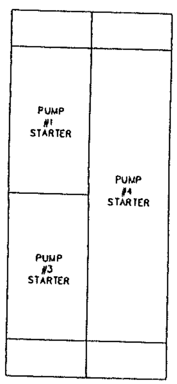
MCC ELEVATION A

SCALE: 3/4"=1'-0"



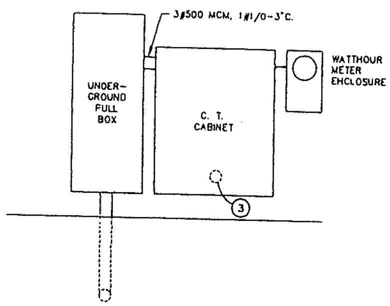
MCC ELEVATION B

SCALE: 3/4"=1'-0"



MCC ELEVATION C

SCALE: 3/4"=1'-0"

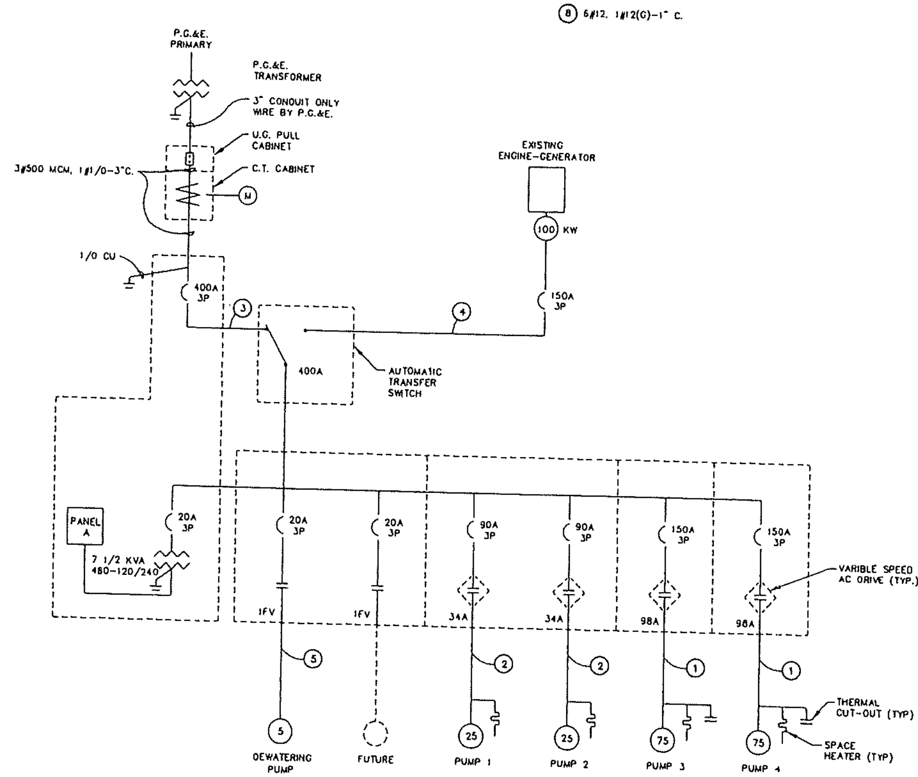


EXTERIOR ELEVATION D

SCALE: 3/4"=1'-0"

CONDUIT SCHEDULE

1. 3#1, 4#12, 1#6(G)-1 1/2" C.
2. 3#4, 4#12, 1#8(G)-1 1/2" C.
3. 3#5 VOMCM, 1#1/0, 1#1/0(G)-3" C.
4. 3#1/0, 1#1, 1#6(G)-2" C.
5. 3#12-3/4" C.
6. 1-RG 62U-1" C.
7. 2#10, 10#12-1 1/2" C.
8. 6#12, 1#12(G)-1" C.



SINGLE LINE DIAGRAM

SCALE: NONE

NOTE:
PANEL A 16 CIRCUIT W/ MAIN CIRCUIT BREAKER.
RECONNECT ALL EXISTING 120 AND 240 VOLT CURCUITS.

WALNUT PUMP STATION

SAN BRUNO CREEK FLOOD CONTROL PROJECT
WALNUT PUMP STATION RENOVATION

Date 8/10/97
Scale AS SHOWN
Design
Drawing # P8
No. Revisions

APPENDIX C: WALNUT PUMPING STATION WET WELL OPERATION LEVELS AND NORTH CANAL WATER ELEVATION EMAIL CORRESPONDENCE DATED SEPTEMBER 30, 2009, FROM ANNA MUI, COUNTY OF SAN MATEO.

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Kelley, Tim

From: Banyai, Timothy
Sent: Wednesday, September 30, 2009 11:33 AM
To: Kelley, Tim; Siew, Meng
Subject: FW: Walnut Stormwater Pumping Station

Tim and Meng

FYI

I will send the serial numbers to Johnston.

Tim

From: Anna Mui [mailto:amui@co.sanmateo.ca.us]
Sent: Wednesday, September 30, 2009 11:32 AM
To: Banyai, Timothy
Subject: Re: Walnut Stormwater Pumping Station

Hi Tim,

Here's the response from San Bruno.

-Anna

Walnut station

75 horsepower pumps- #2 Serial number 97JT2694 A
#4 Serial Number 97JT2694 B

Wet well levels-

De-watering pump *ON* at 3' *OFF* at 2.5"

25 HP pumps *ON* at 3.5 *OFF* at 3.0

75 HP Lead alternation *ON* at 5' *OFF* at 3.0"
75 HP Lag alternation *ON* at 5.5" *OFF* at 3.0"

Canal Depths-

From road grade/top of canal (9 feet deep too top of silt). Silt is believed to be approx. 2 to 4 feet. **Total** between 11 to 13 feet

Angus Station

Wet Well Levels-

Lead alternating *ON* at 12' *OFF* at 5.7"
Lag alternating *ON* at 12.5" *OFF* at 5.7"

Canal depth-

Anywhere between 9 to 12 feet. It should be measured.

Save Paper. Think Before You Print.

>>> "Banyai, Timothy" <TBanyai@BrwnCald.com> 9/29/2009 1:25 PM >>>

Anna

We have called Johnston pumps trying to get the pump curve for the 75 horsepower pumps at Walnut Stormwater Pumping Station. They tell us that we need to provide the serial number. When we were out at the site, the serial number was not visible. Can you provide us with the serial number so we can get the pump curve for this pump?

Thanks

APPENDIX D: FIGURE 1-1 OF ASCE 31

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ASCE/SEI 31-03

ASCE STANDARD

American Society of Civil Engineers

Seismic Evaluation of Existing Buildings

ASCE

SEI
Structural Engineering Institute

Library of Congress Cataloging-in-Publication Data

Seismic evaluation of existing buildings / American Society of Civil Engineers.
p. cm. -- (ASCE standard)
Includes bibliographical references and index.
"SEI/ASCE 31/02."
ISBN 0-7844-0670-7
1. Buildings--Earthquake effects. I. Structural Engineering Institute II. American Society of Civil Engineers.

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693.8'52--dc21

2003041921

Published by the American Society of Civil Engineers
1801 Alexander Bell Drive
Reston, Virginia 20191
www.asce pubs.asce.org

Library of Congress Catalog Card No: 2003041921
ISBN 0-7844-0670-7
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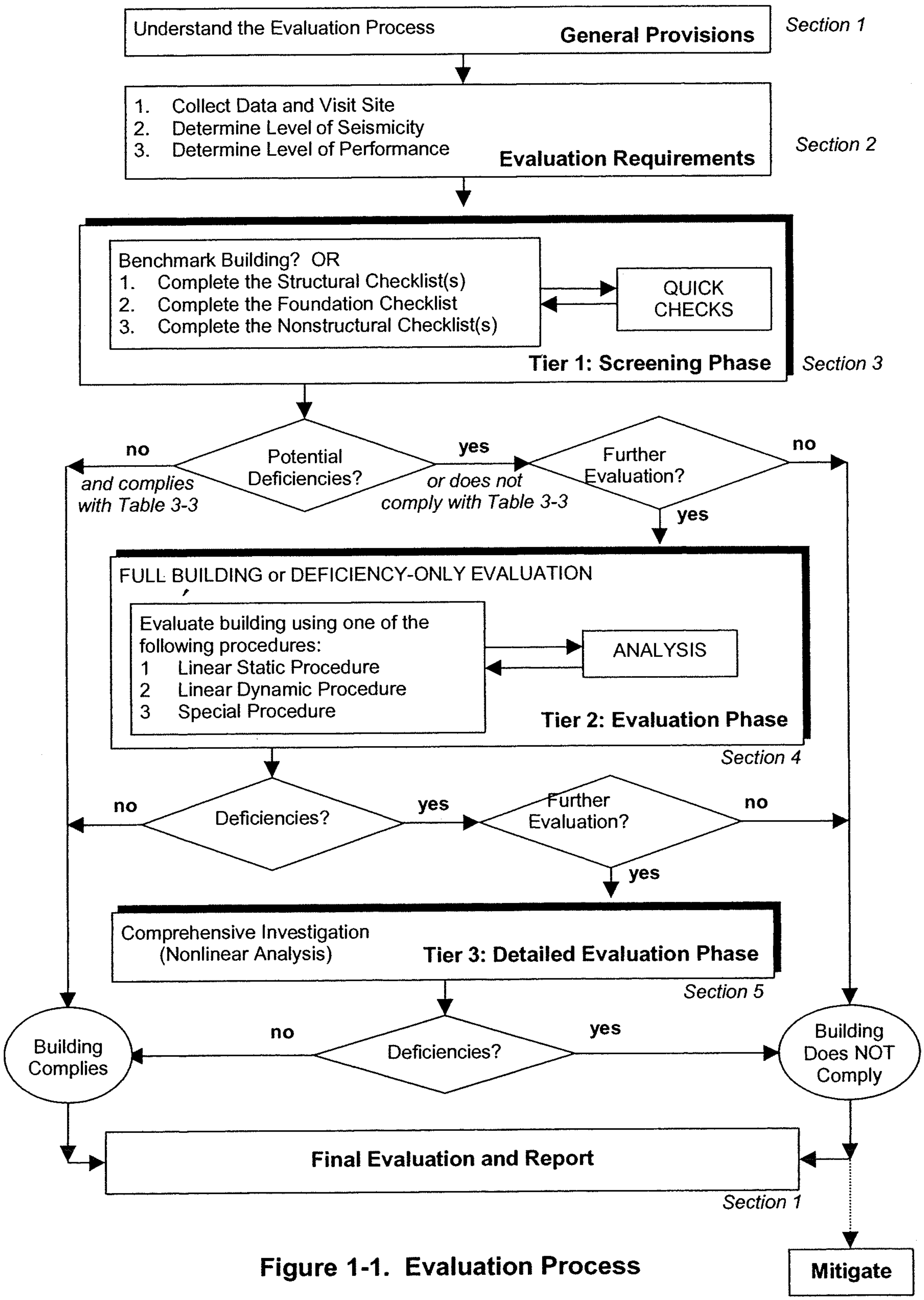

Figure 1-1. Evaluation Process

APPENDIX E: ANGUS PUMPING STATION: EXISTING MANUFACTURER PUMP CURVES

Johnston Vertical Propeller Pump Model HG-250 Pump Curves Serial Number GA-3838, dated July 16, 1968

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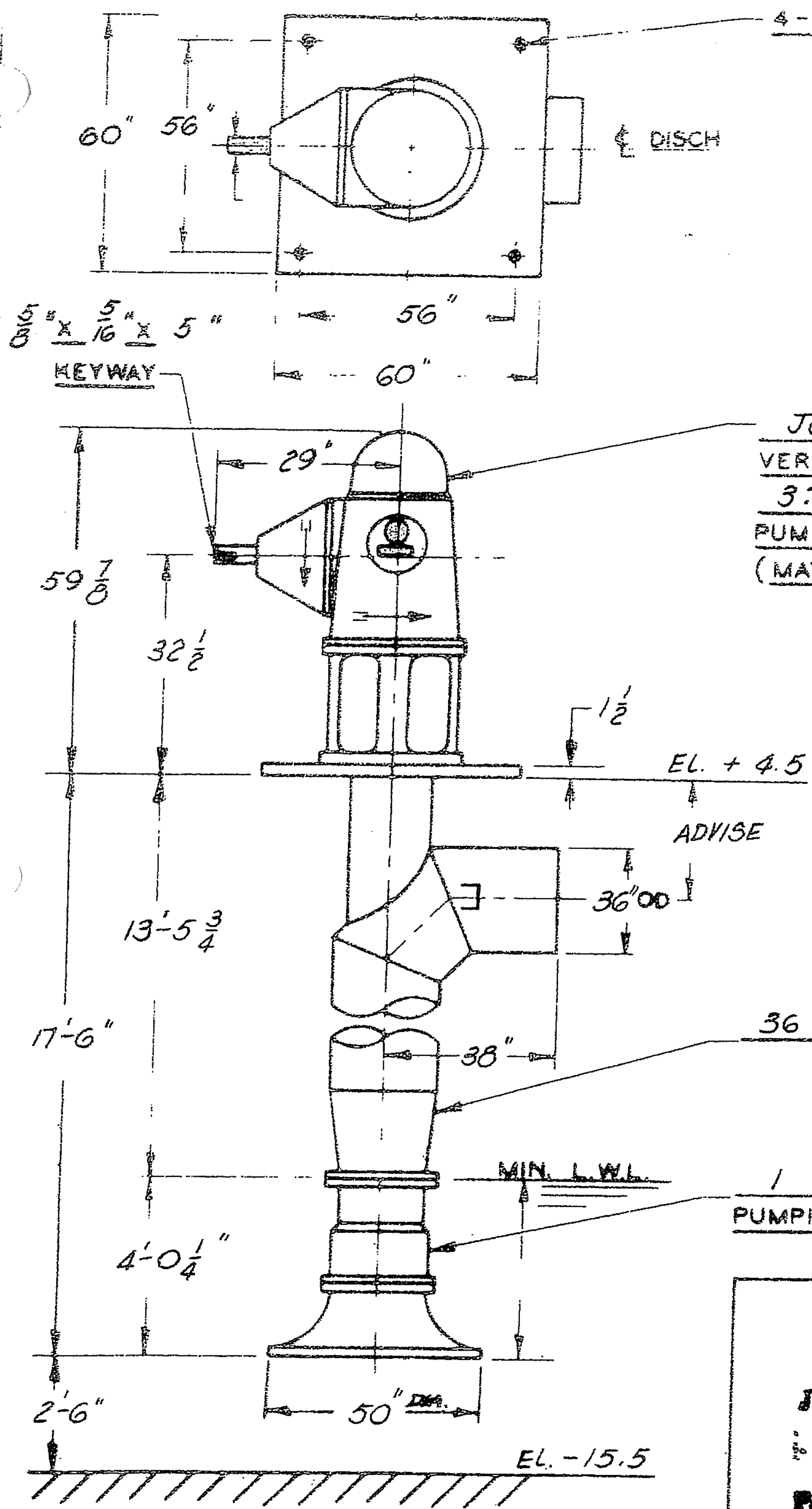
JOHNSTON PROPELLER PUMP

ANGUS
1/3



JOHNSON MODEL HG-250
VERTICAL HOLLOW SHAFT GEAR DRIVE
3:1 RATIO - SPEED DECREASING
PUMP RPM 585
(MAY BE ROTATED IN 90° INCREMENTS)

36" - 3" x 2 3/16 LUBRICATED COL. ASSEMBLY

1 STAGE 30 PO BOWL ASSEMBLY
PUMPING CONDITIONS - 30 000 GPM
13.5 FT. TDH

THIS PRINT CERTIFIED CORRECT BY JOHNSTON PUMP COMPANY

Original Signed by
Per H. A. J. CREUTINK

CUSTOMER SAN MATEO COUNTY
SAN BRUNO CREEK FLOOD CONTROL
CONTRACTOR: Mc. GUIRE & HESTER
PO
JOHNSTON PUMP SERIAL NO. GA-3838-39

DO NOT USE FOR CONSTRUCTION
UNLESS CERTIFIED ABOVE

JOHNSTON PUMP COMPANY
GLENDORA, CALIFORNIA

NEW STATION
PUMP NO. 1 & 2

M.B 7-16-68

DRWG. NO. DP-J

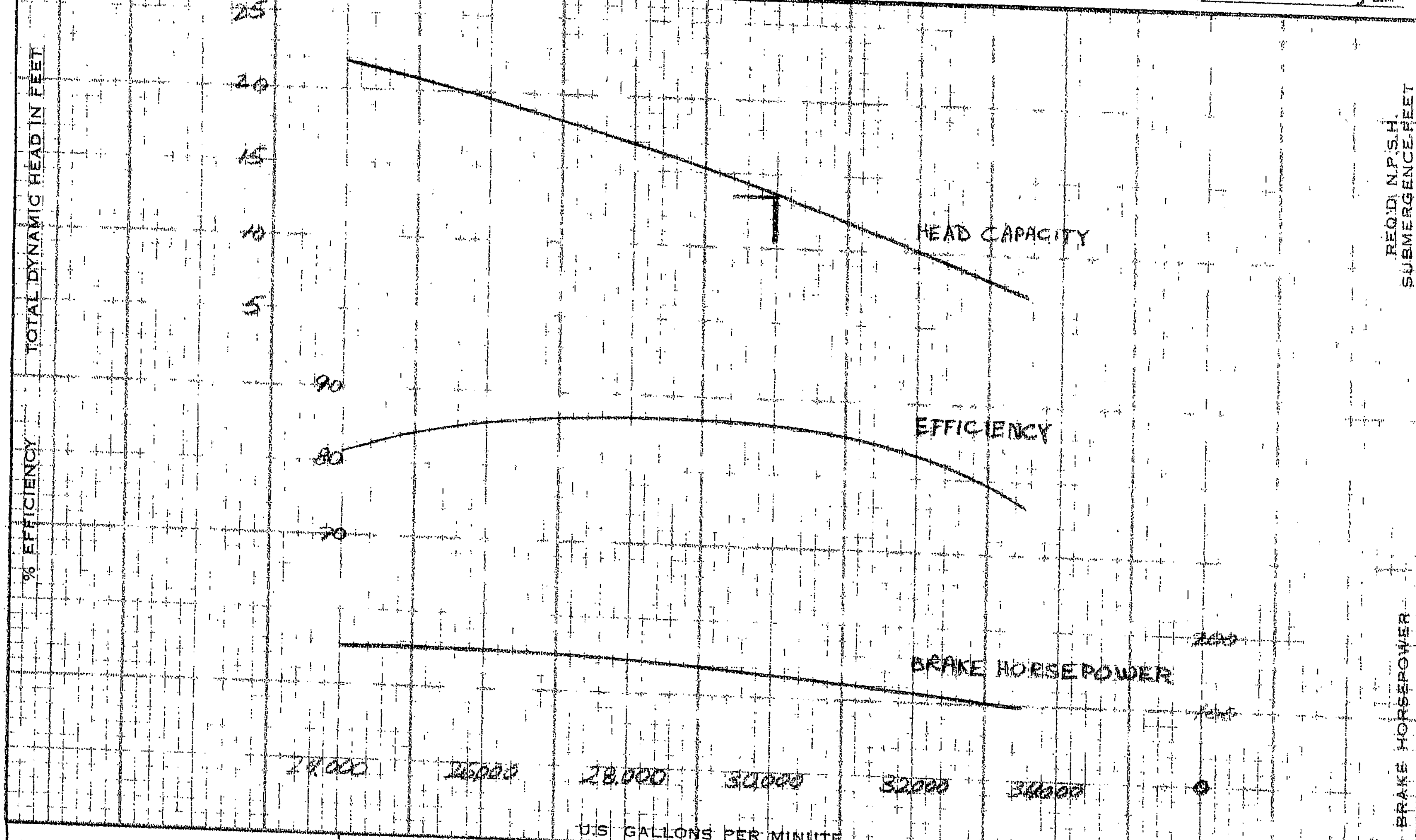
H-1598A

NC Nil COLUMN LOSSES ARE INCLUDED

JOHNSTON REF. NO. GA 3838-39

DEALER: McGUIRE & HESTER REF. NO. 1896

CUSTOMER: SAN BRUNO CREEK REF. NO. PUMP #1,2



THE CAPACITY, HEAD AND EFFICIENCY GUARANTEE IS FOR THE DESIGNATED POINT ONLY: IT IS BASED ON SHOP TESTS, WHEN HANDLING CLEAR, FRESH WATER AT A TEMPERATURE OF NOT OVER 85° F. AND UNDER SUCTION CONDITIONS AS SPECIFIED IN THE CONTRACT.

IMPELLER ________ DIA. ________

BOWLS ________

LIQUID WATER

SP. GR. 1.0

DATE 7/23/68 BY DS

JOHNSTON PUMP CO.

VERTICAL PUMPS

GLENDORA · CALIFORNIA · U. S. A.

PROPELLER PERFORMANCE

1 STAGE 30 P.O. PUMP

585 R.P.M

(2/3)

JP-319-3M

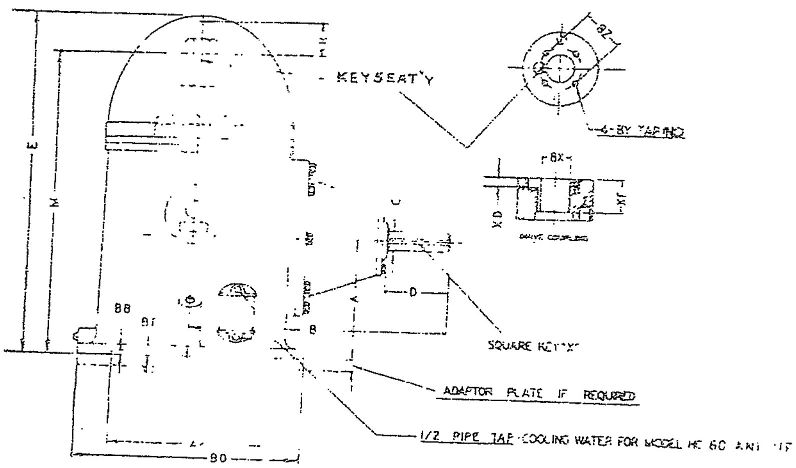
JOHNSON GE R & MANUFACTU ING CO Ltd. (3/3)

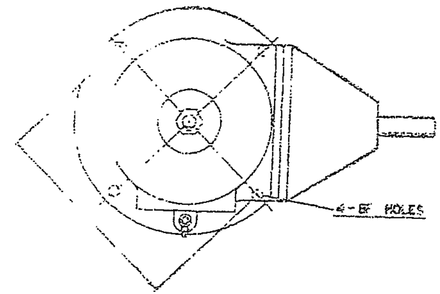
APPROVED FOR CONSTRUCTION

Customer Johnston Pump Company
Customer's Order No. 12104 (2) Model HG250 Type NR
Serial No. 42791-92 Drive Coupling "BX" 2 3/16" Ratio 3:1
Approved by GMP Date 6/26/68 Rotation Fig. 1

SAN BRUNO CREEK FLOOD CONTROL DISTRICT

UPTHRUST CONTROL





STANDARD DIMENSIONS OF JOHNSON RIGHT ANGLE GEAR DRIVES

Model	A	B	C	D	E	H	M	BE	BD	AJ	AK	BB	BF	Keyseat X
HA15	6 3/8	13	1 1/8	2 3/4	17 1/8	2 1/4	14 1/2	5/8	1	8 1/8	8 1/4	3/16	7/16	1/4 x 1/8 x 2 1/2
HX25	9	16	1 1/2	3 1/2	23	2 3/8	20 1/4	3/4	2	9 1/8	8 1/4	3/16	7/16	3/8 x 3/16 x 3
HB40	9	16	1 1/2	3 1/2	23	2 3/8	20 1/4	[illegible]	16 1/2	14 3/4	13 1/2	3/16	11/16	3/8 x 3/16 x 3
HC60	9	16	1 1/2	3 1/2	23	2 3/8	20 1/4	3/4	16 1/2	14 3/4	13 1/2	3/16	11/16	3/8 x 3/16 x 3
HD90	11 3/8	17 1/2	2	3 1/2	27 3/4	2 3/8	25	1	16 1/2	14 3/4	13 1/2	3/16	11/16	1/2 x 1/4 x 3
HE150	13 1/4	20 1/2	2 1/4	4 3/4	33	2 5/8	29 7/8	1	20	14 3/4	13 1/2	3/16	11/16	1/2 x 1/4 x 4
HF200	15	24	2 1/4	5 1/2	38 1/4	3 3/8	34 1/4	1 1/8	20	14 3/4	13 1/2	3/16	11/16	1/2 x 1/4 x 5
HG250	16 1/2	29	2 3/4	5 1/2	43 7/8	4 3/4	38 1/2	1 1/4	24 1/2	22	13 1/2	3/8	15/16	5/8 x 5/16 x 5
HH350	16 1/2	30	2 3/4	5 3/4	43 7/8	4 1/8	39 1/8	1 1/4	24 1/2	22	13 1/2	3/8	15/16	5/8 x 5/16 x 5
HH425	16 1/2	30	2 3/4	5 3/4	43 7/8	4 1/8	39 1/8	1 1/4	24 1/2	22	13 1/2	3/8	15/16	5/8 x 5/16 x 5
HI 500	16 1/2	31 1/2	3	6	47	4	42 3/8	1 1/4	24 1/2	22	13 1/2	3/8	15/16	3/4 x 3/8 x 5
HJ600	19	34	3	5 1/2	54	7 5/8	45 3/4	1 1/2	30 1/2	26	22	3/8	15/16	3/4 x 3/8 x 5

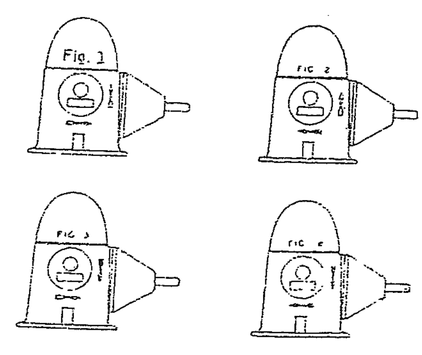
XXX

MAX. DRIVE COUPLING AND KEYSEAT

Model	XF	XD	BX Fig. 1 & 4	BX Fig. 2 & 3	BY	BZ	Y
HA15	1 3/8	5/16	3/4	3/4	10-32	1 3/8	3/16 x 3/32
HX25	1 3/4	9/16	1 1/2	1 1/4	1/4-20	2 1/8	3/8 x 3/16
HB40	1 3/4	9/16	1 1/2	1 1/4	1/4-20	2 1/8	3/8 x 3/16
HC60	1 3/4	9/16	1 1/2	1 1/4	1/4-20	2 1/8	3/8 x 3/16
HD90	2 1/8	9/16	1 1/2	1 1/2	1/4-20	2 1/8	3/8 x 3/16
HE150	2 3/8	9/16	1 15/16	1 3/4	1/4-20	2 1/2	1/2 x 1/4
HF200	2 5/8	11/16	2	2	1/4-20	2 1/2	1/2 x 1/4
HG250	3	11/16	2 3/16	2 3/16	3/8-16	3 1/4	1/2 x 1/4
HH350	3 1/4	13/16	2 7/16	2 7/16	3/8-16	3 1/2	5/8 x 5/16
HH425	3 1/4	13/16	2 7/16	2 7/16	3/8-16	3 1/4	5/8 x 5/16
HI 500	4	1	2 11/16	2 11/16	3/8-16	4 1/2	7/8 x 7/16
HJ600	4	1	3 1/2	3	3/8-16	4 1/2	7/8 x 7/16

XX

ROTATION DIAGRAM



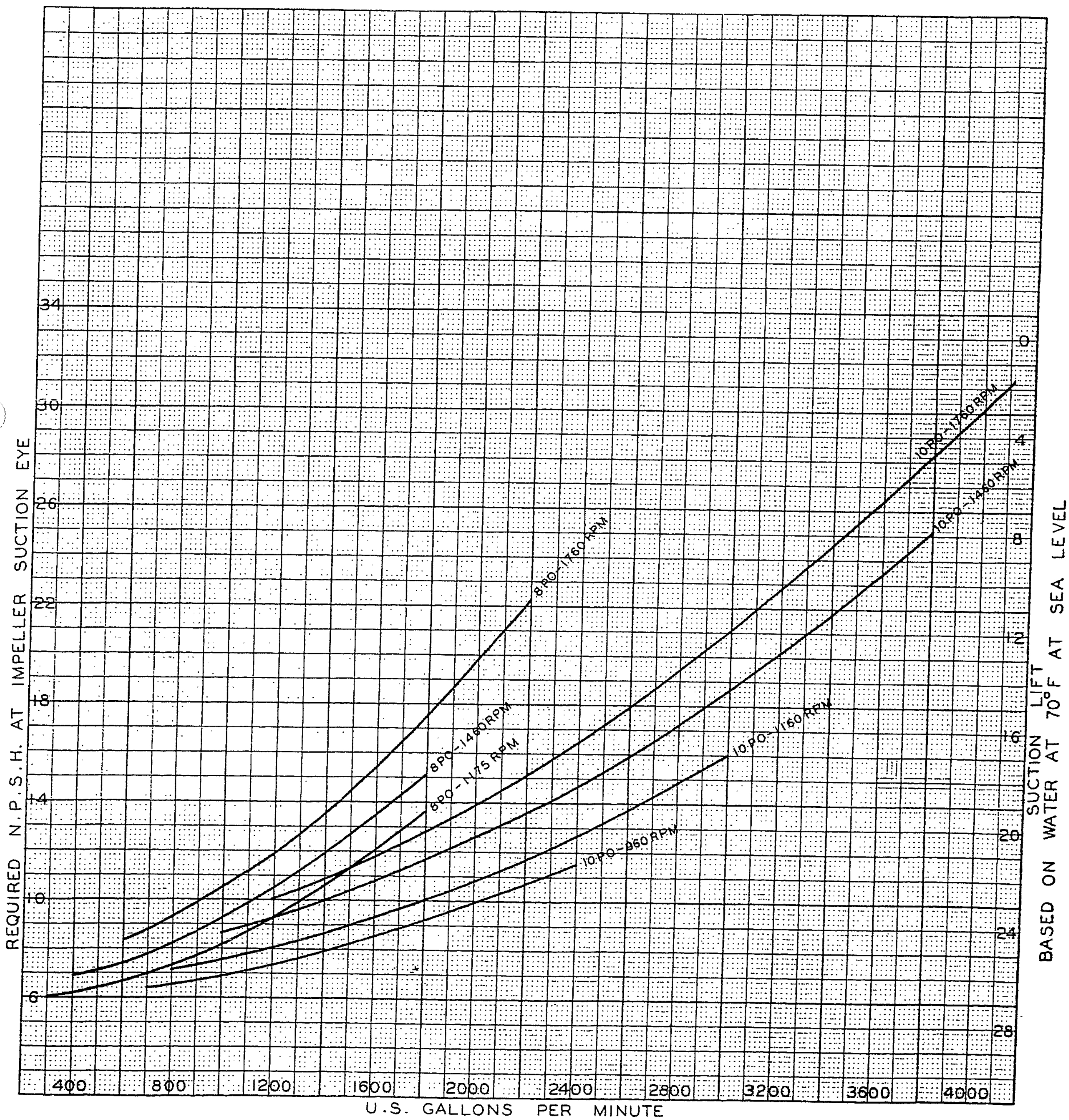
Special BX	BX	Y	BY	BZ	XD

Tolerances: Drive Shaft "C" plus .000 minus .001, Base Rabbet "AK" plus .002 plus .005 Coupling Bore "BX" plus .0005 plus .0015. Unfinished cast surfaces subject to normal variation.

BERKELEY 10, CALIFORNIA U.S.A.

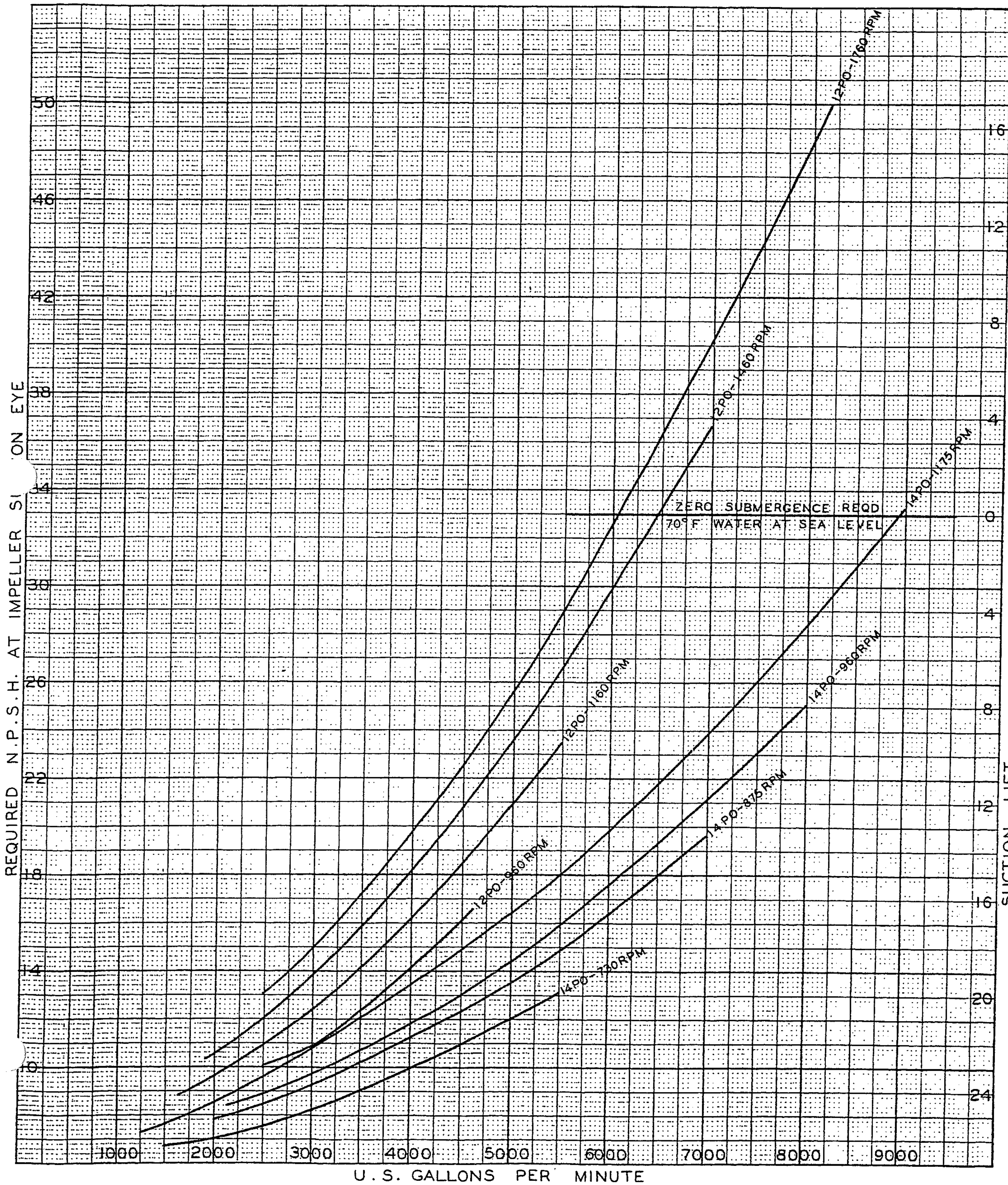
Johnston Pump Company
Brookshire, Texas 77423
ESTABLISHED 1909

PROPELLER PUMPS
NET POSITIVE SUCTION HEAD REQUIREMENT



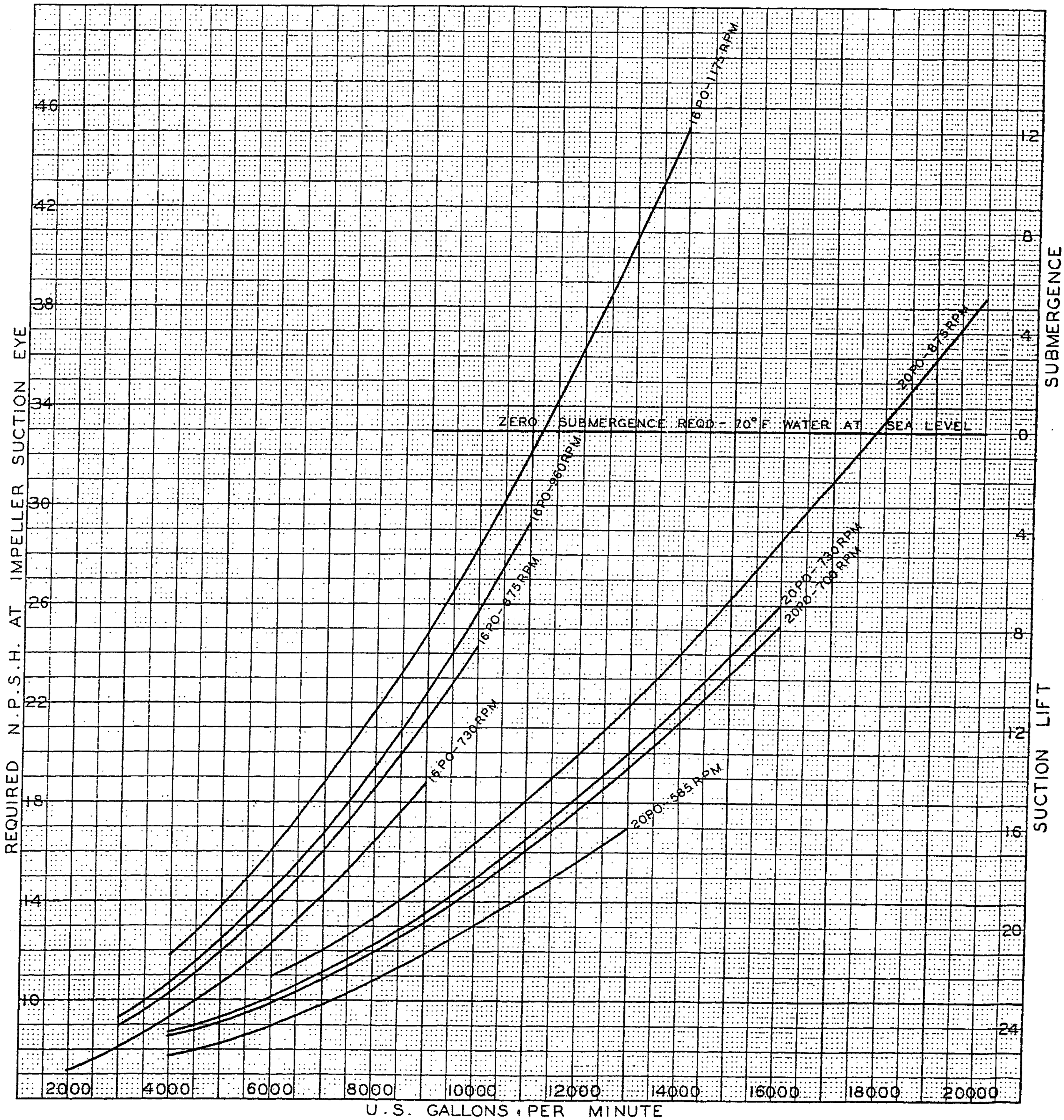
Johnston Pump Company
Brookshire, Texas 77423
ESTABLISHED 1909

PROPELLER PUMPS
NET POSITIVE SUCTION HEAD REQUIREMENT



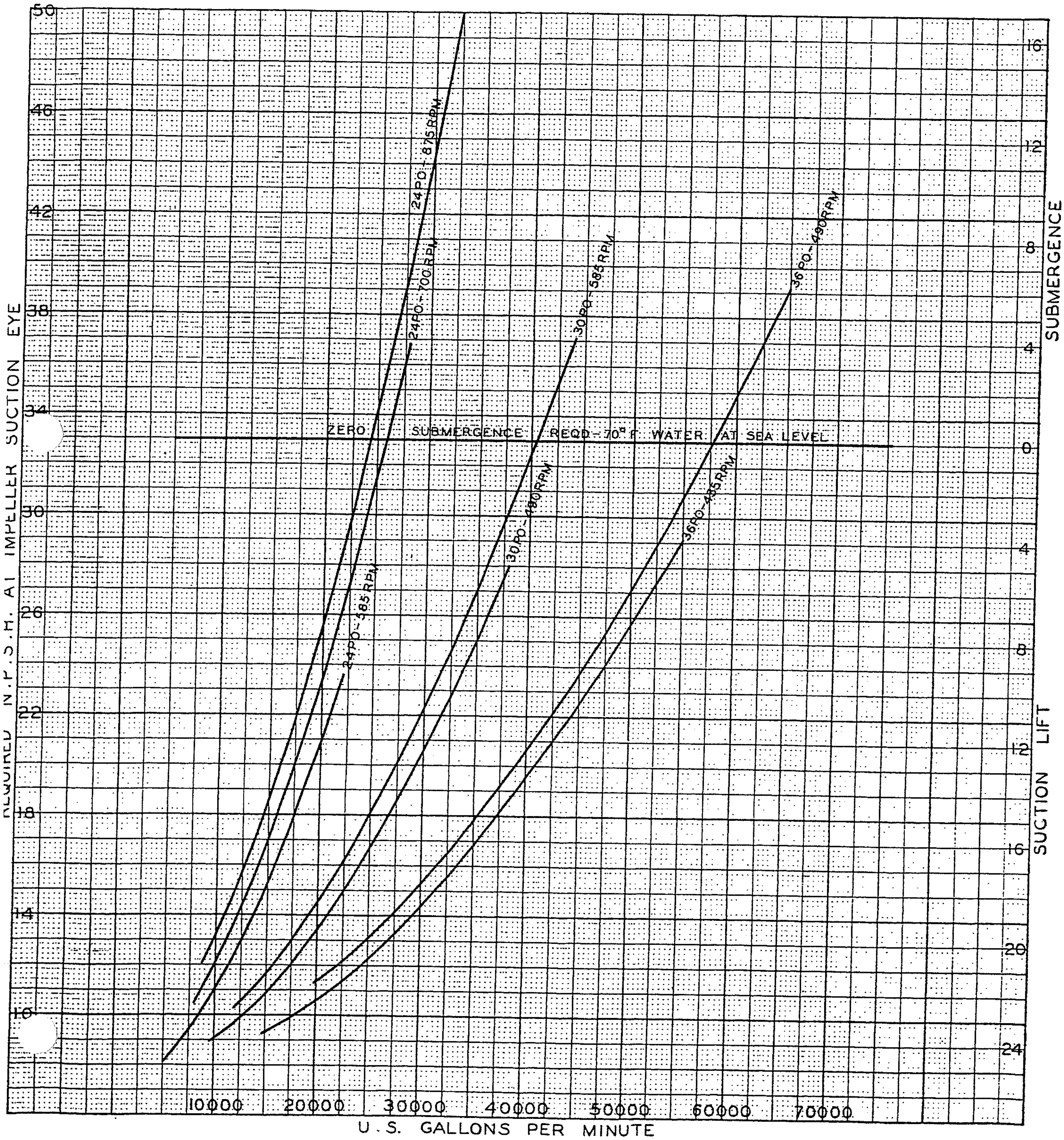
Johnston Pump Company
Brookshire, Texas 77423
ESTABLISHED 1909

PROPELLER PUMPS
NET POSITIVE SUCTION HEAD REQUIREMENT



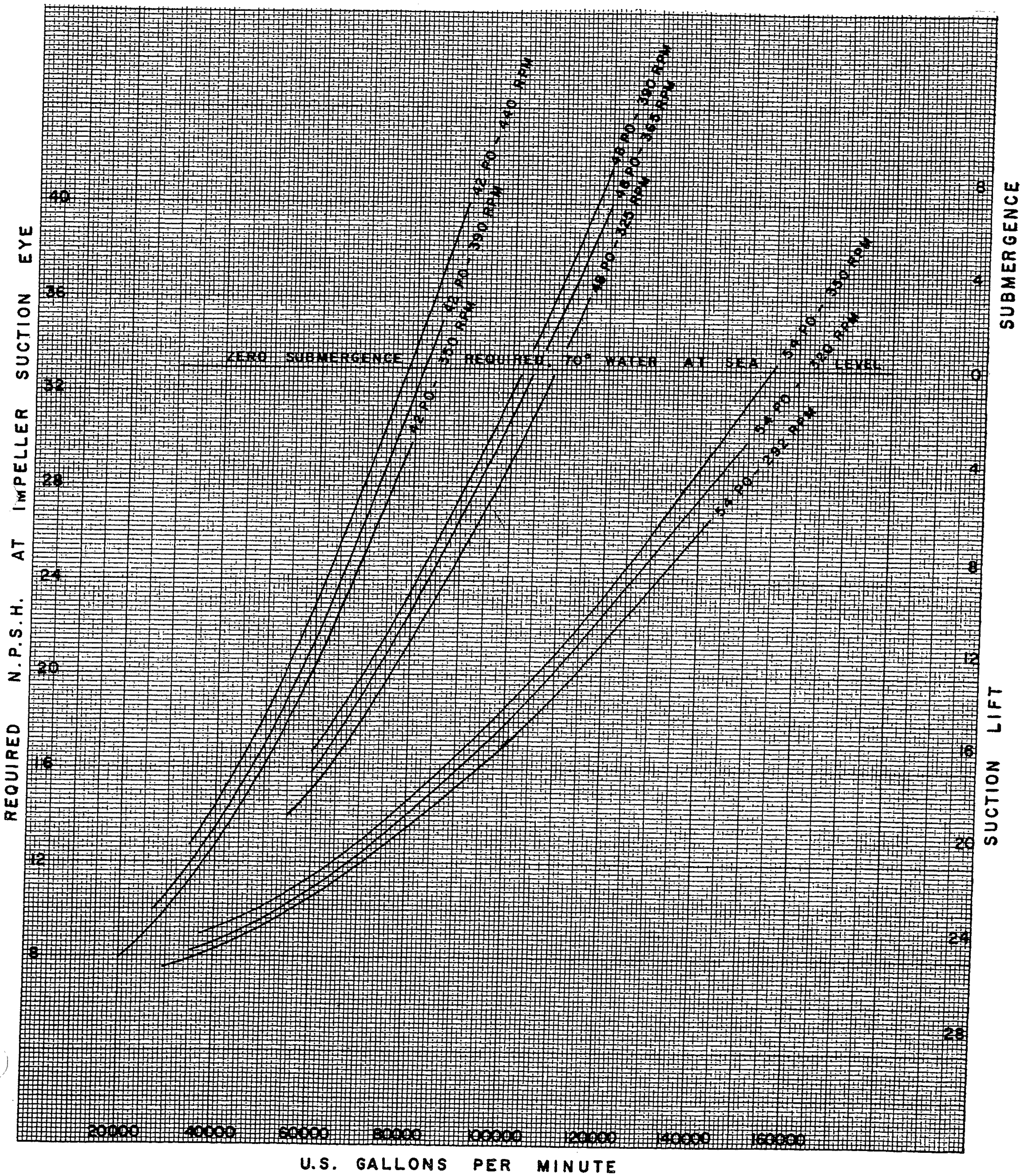
Johnston Pump Company
Brookshire, Texas 77423
ESTABLISHED 1909

PROPELLER PUMPS
NET POSITIVE SUCTION HEAD REQUIREMENT



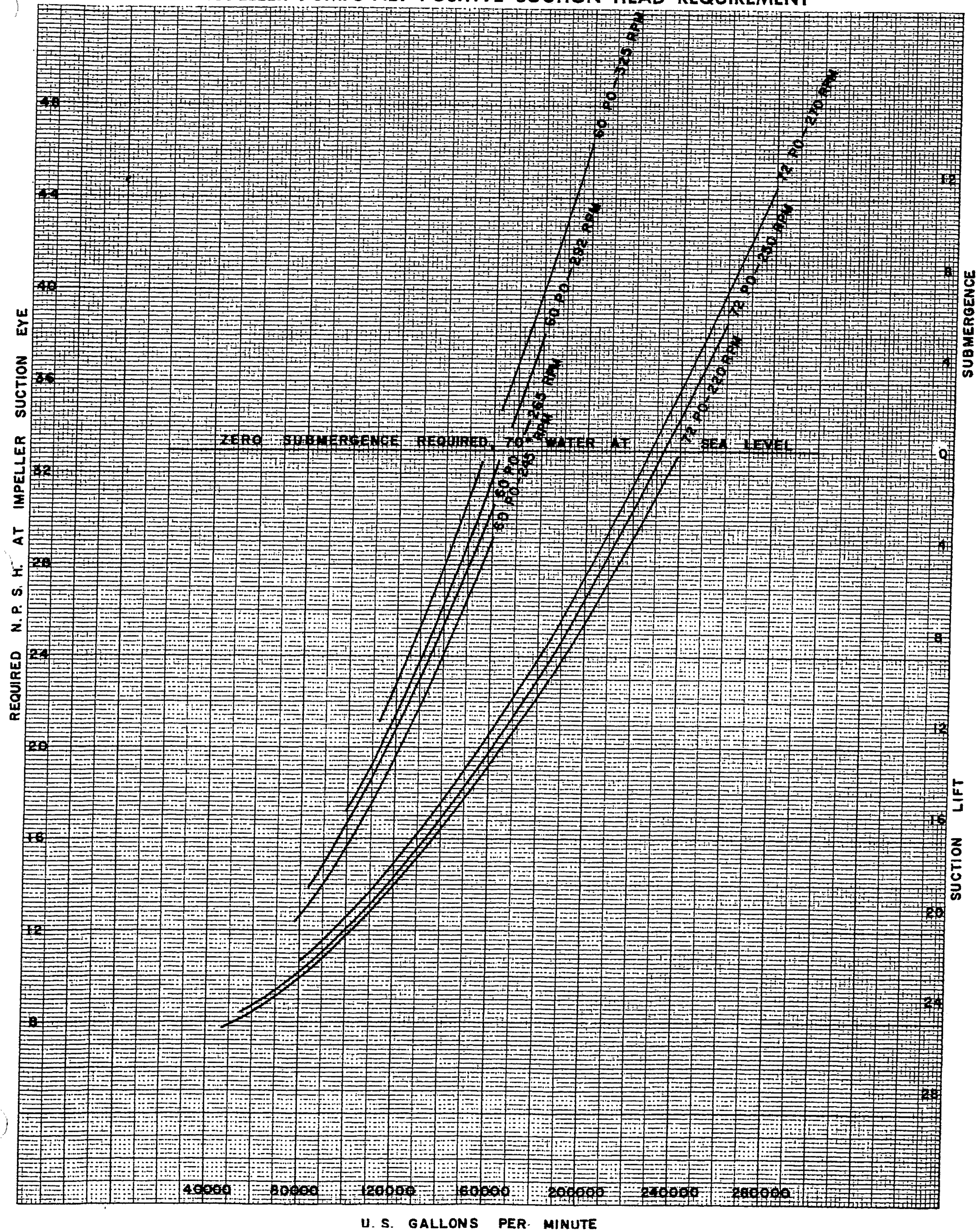
Johnston Pump Company
Brookshire, Texas 77423
ESTABLISHED 1909

PROPELLER PUMPS
NET POSITIVE SUCTION HEAD REQUIREMENT



Johnston Pump Company
Brookshire, Texas 77423
ESTABLISHED 1909

PROPELLER PUMPS NET POSITIVE SUCTION HEAD REQUIREMENT



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APPENDIX F: SAN BRUNO CREEK FLOOD CONTROL PROJECT – NEW PUMP STATION SITE AND MISCELLANEOUS DETAILS DRAWINGS DATED APRIL 1968 PREPARED BY WILSEY AND HAM

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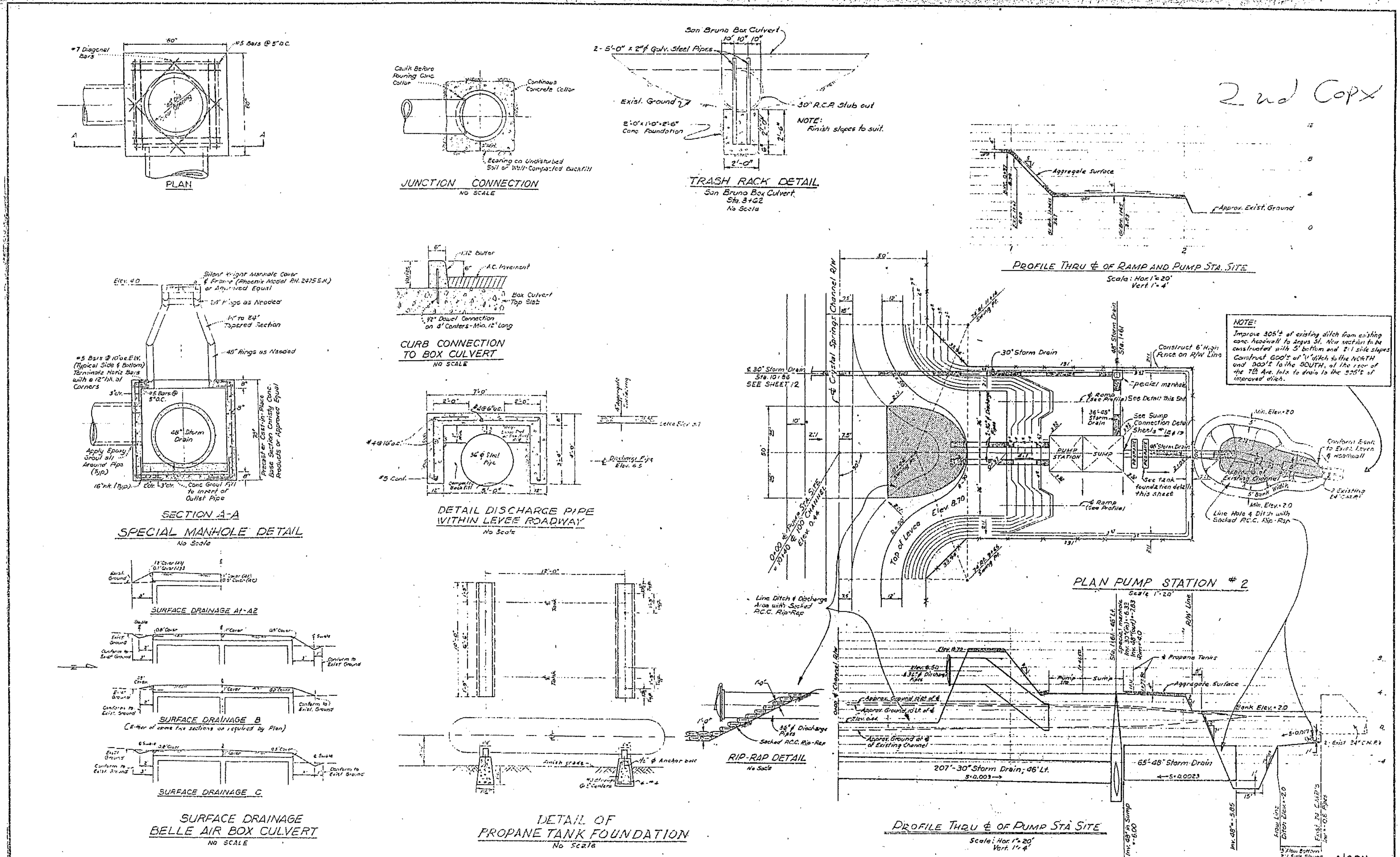

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4/2811

WILSEY & HAM

SAN BRUNO CREEK FLOOD CONTROL PROJECT
NEW PUMP STATION SITE
& MISCELLANEOUS DETAILS
SAN MATEO COUNTY FLOOD CONTROL DISTRICT
SAN MATEO COUNTY — CALIFORNIA

17/24

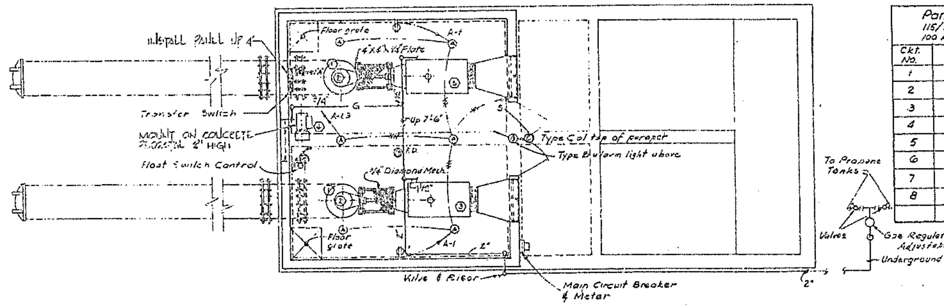
053-1001-20-E1

Scale: AS SHOWN

Date: April – 1968

Angus Pump Station

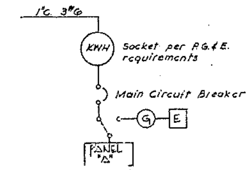
~~13-8~~ To 13810



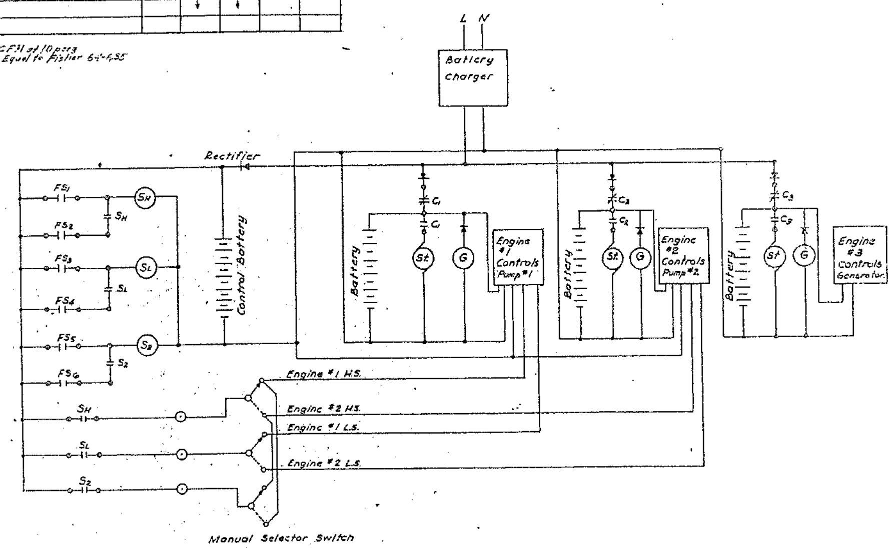
PLAN
Scale: 1/4" = 1'-0"

Ckt. No.	Description	Wire Size	No. of Poles	Trip Amps	Load VA Phase A	Load VA Phase B
1	Lights	12	1	15	900	
2	Engine Jacket Heater	↓	↓	15	1000	
3	Convenience Outlets			20		360
4	Engine Jacket Heater			15		1000
5	Battery Charger	↓		15	150	
6	Space			50		
7	↓		↓	↓		
8	↓					

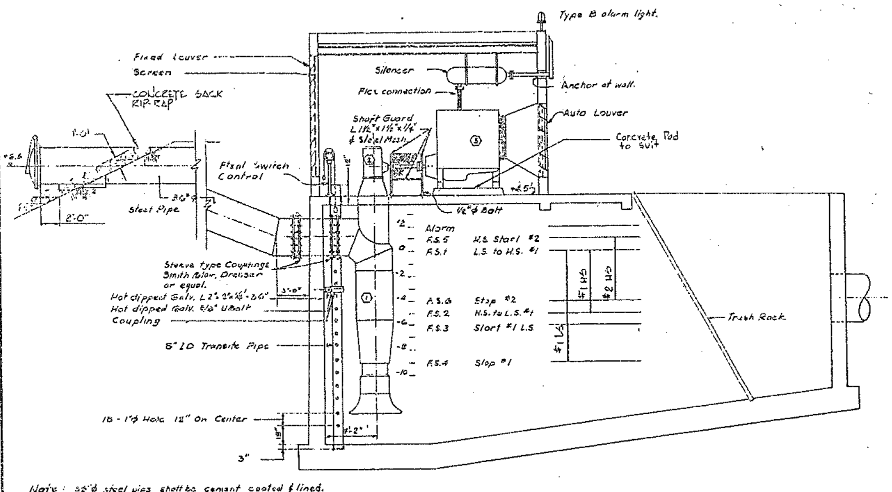
Panel A
115/230 Volt 1φ 3W
100 A Bus 50 A Main C. Br.



ONE LINE DIAGRAM



SCHEMATIC CONTROL DIAGRAM



Note: 30"φ steel pipes shall be cement coated & lined.

SECTION
Scale: 1/4" = 1'-0"

LEGEND

- (S) Relay coil, letter identifies relay
- (St) Engine starter
- (G) Alternator (Generator)
- Rectifier, diode
- N.C. contact letter and number indicate relay
- N.O. contact
- Engine starting relay contact, number indicates engine number.
- FS_1 - FS_6 float switch contact
- Terminal
- Wires connected
- Wires crossing - not connected.

See sheet 22 for Fixture schedule.

EQUIPMENT SCHEDULE

- ① Pump
- ② Gear
- ③ Engine
- ④ Stand by Electric Generator.

Batteries: Nickel Cadmium - Plastic case
1. Engine starting: 80 Ampere hours, 12V. - 10 cells 780A 60 seconds to .65V per cell.
2. Control: 30 Ampere hours, 12V. - 10 cells 3.0A 10 hrs to 1.10V per cell.
3. Generator: 8.5 Ampere hours 12V - 10 cell 100A 60 seconds to .65V per cell.
Battery Charger: 12V (10 cells) 30A capacity
Diode Rectifiers: 20 A capacity, min.

NOTE:
1. ELECTRICAL SERVICE TO BE UNDERGROUND.
2. MOUNT CONVENIENCE OUTLETS UP 30".
3. MOUNT BATTERIES WITH TERMINALS 30" ABOVE FLOOR, BOLT STANDS TO FLOOR.
4. ALL CIRCUIT BREAKERS, SWITCHES, AND TERMINALS TO BE INSTALLED NOT LESS THAN 30" ABOVE FLOOR.
5. PROVIDE SHUT-OFF COCK IN GAS LINE AT EACH ENGINE.

4/2811

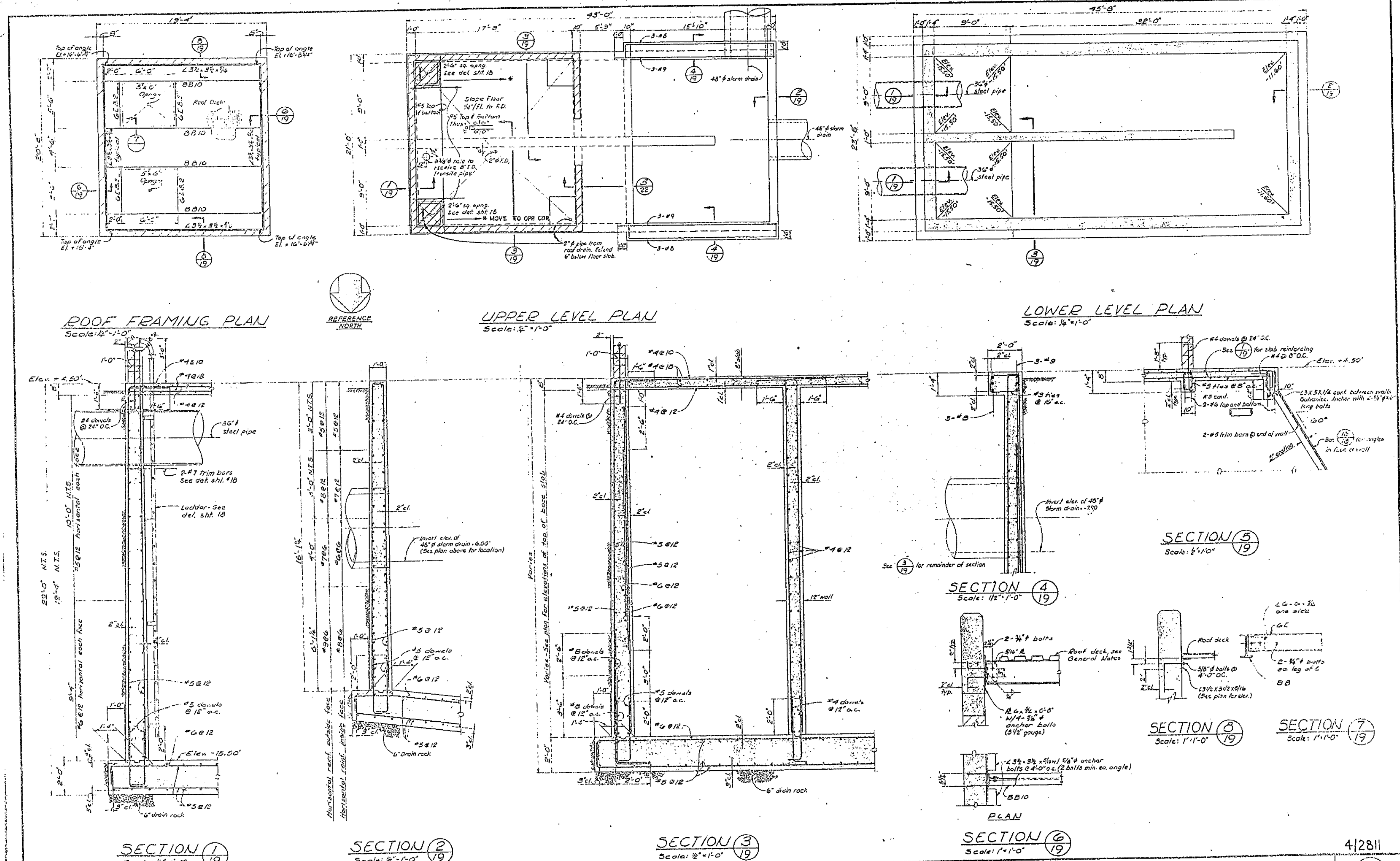
WILSEY & HAM
SAN BRUNO CREEK FLOOD CONTROL PROJECT
PUMP STATION NO. 2 (NEW)
ELECTRICAL & MECHANICAL DETAILS
SAN MATEO COUNTY FLOOD CONTROL DISTRICT
SAN MATEO COUNTY CALIFORNIA

Design: WG 12/67
Drawn: HT 12/67
Ckd: WG

20/24

SCALE: AS SHOWN

Angus Pump Station



4|2811

NOTES: 1. See sheet 18 for general notes

REVISIONS

WILSEY & HAM

SAN BRUNO CREEK FLOOD CONTROL PROJECT

PUMP STATION NO. 2 (NEW)

STRUCTURAL DETAILS

SAN MATEO COUNTY FLOOD CONTROL DISTRICT

SAN MATEO COUNTY CALIFORNIA

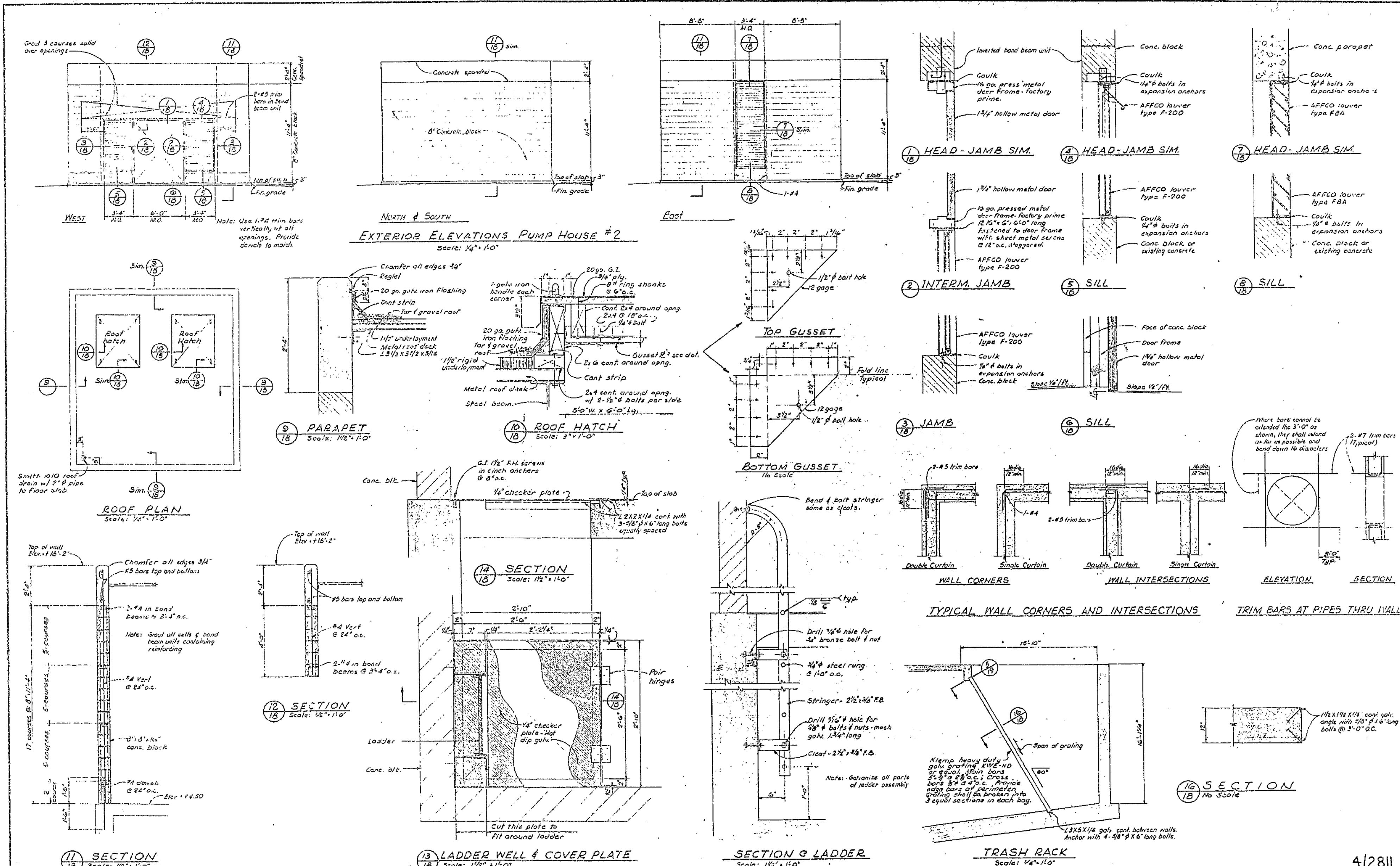
19/24

083-1001-20-E1

SCALE AS SHOWN

DATE April 1969

Angels Pump Station



NOTES:

1. Roof deck shall be 22 gauge galvanized metal decking with a depth of 1 1/2" and having a minimum section modulus of 0.203 in³ and moment of inertia of 0.180 in⁴.
2. Soils Report was prepared by Cooper-Clark & Associates, Palo Alto, dated October 6, 1967.
3. Concrete shall have a 28 day compressive strength of 3000 #/□"
4. All structural steel shall be A-36
5. Anchors to concrete shall be 3 unit cinch anchors as manufactured by the National Lead Co., Chicago, Illinois.
6. Roof deck shall be fastened at 12" ctrs. at ends of deck units and intermediate supports with 3/4" ϕ plug welds. Button punch side laps @ 3'-0" o.c. Deck at side supports shall be fastened with 3/4" ϕ plug welds @ 12" o.c.

	By	Date
Design	A.M.	12/67
Drawn	A.M.	12/67
Chk.	K.W.	
Chk./Comp.		
Fld. Eng.	J.P.	
Mr. Eng.	D.R.	
Fd. Bk. No.		

APPROVED

4/2811

WILSEY & HAM

SAN BRUNO CREEK FLOOD CONTROL PROJECT

PUMP STATION NO. 2 (NEW)

ARCHITECTURAL DETAILS

SAN MATEO COUNTY FLOOD CONTROL DISTRICT

SAN MATEO COUNTY — CALIFORNIA

18/24

DWG. NO. 083-1001-20-E1

SCALE: AS SHOWN

DATE: April – 1968

Angus Pump Station

REFERENCES

Garr M. Jones, *Pumping Station Design*, Third Edition, Butterworth-Heinemann, 2008.

Storm Drain Master Plan Study Analyses for the City of San Bruno, 1991

Pumping Station Upgrade, 1997

Update Storm Drain Master Plan Study Analyses for the City of San Bruno, 2001

Walnut Storm Water Pumping Station, 2006

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American Pipe Manual – 18th Edition, 1999

California Electrical Code (CEC, 2007)

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