

Appendix A.

Summary of NOTL Information Received
File Name

File Name	Type	Category	Author	Item	Status	Format	Compiled	Received	Source/Cor Notes/Action Item
AECOM Request for Clarification, Questions, Info Log INTERNAL.xlsx	RFI	CONSULTATION	AECOM	Request for Information (RFI)	IN PROCESS	XLS	2025	09-2025	AECOM
Drained Lower Reservoir - 20150730-1.jpg	IMAGE	TECHNICAL	Niagara Region	Image - Silt Accumulation	RECEIVED	JPG	2015	12-2025	RMR
By-law No. 3534-01 (Consolidate the Irrigation System).pdf	BY-LAWS	REGULATORY	NOTL	By-Law 3534 - Irrigation System Consolidation	RECEIVED	PDF	2001	09-2025	NOTL
3474-00 ABL Non Consolidated.pdf	BY-LAWS	REGULATORY	NOTL	Irrigation System Installation By-Law	RECEIVED	PDF	2000	09-2025	NOTL
4220-08 Irrigation enforcement.pdf	BY-LAWS	REGULATORY	NOTL	Irrigation System Enforcement By-Law	RECEIVED	PDF	2008	09-2025	NOTL
Bill Pr88.pdf	STATUTE	REGULATORY	Ontario Government	Bill Pr88	RECEIVED	PDF	1990	09-2025	NOTL
By-law 3008-96 (A B C D) 001.pdf	BY-LAWS	REGULATORY	NOTL	By-Law 3008D-99 - Harrison Irrigation System	RECEIVED	PDF	1996	09-2025	NOTL
By-law 3135 (A B C) 001.pdf	BY-LAWS	REGULATORY	NOTL	By-Law 3135C-99 - Four Mile Creek Irrigation System	RECEIVED	PDF	1997	09-2025	NOTL
By-law 3324-99 (A) 001.pdf	BY-LAWS	REGULATORY	NOTL	By-Law 3324A-99 - Airport-Carlton Shiphon Irrigation System	RECEIVED	PDF	1999	09-2025	NOTL
By-law 3387-99 001.pdf	BY-LAWS	REGULATORY	NOTL	By-Law 3387-99 - Harrison A & B Irrigation System	RECEIVED	PDF	1999	09-2025	NOTL
enforcement by-law newspaper add.doc	BY-LAWS	REGULATORY	NOTL	By-Law 4420-08 - Municipal Irrigation Enforcement By-Law	RECEIVED	DOC	2008	09-2025	NOTL
Carlton St. Ditch Profile info.pdf	DWG - SITE	CAD	Quartek Group Inc.	Carlton Siphon Ditch Profile	RECEIVED	PDF	2012	11-2025	NOTL
Original Drawing Set	DWG - SET	CAD	Wiebe Engineering Group Inc.	Dee Road Pump House	RECEIVED	PDF	2003	11-2025	NOTL
2017 Expansion	DWG - SET	CAD	Quartek Group Inc.	Dee Road Pump House - 2017 Expansion	RECEIVED	PDF	2017	11-2025	NOTL
DFO - Guidance for Maintaining and Repairing Municipl Drains.pdf	PUBLICATION	TECHNICAL	Central and Arctic Region Fisheries and Oceans Canada	Guidance for Maintaining and Repairing Municipal Drains in Ontario	RECEIVED	PDF	2017	11-2025	DSAO
DLA Data	GIS	GIS/CAD		GIS DATA	RECEIVED	GDB	CURRENT	11-2025	RMR
Drone Data	CONTOUR	GIS/CAD		CONTOUR DATA	RECEIVED	GDB	CURRENT	11-2025	NOTL
Flood Mapping	FLOOD	GIS/CAD		FLOOD MAPPING DATA	RECEIVED	GDB	CURRENT	11-2025	NPCA
Grape and Wine Performance Studies Mapping	PUBLICATION	TECHNICAL	VQA Ontario	Ontario Wine and Grape Industry Study	RECEIVED	PDF	2017-2020	11-2025	VQA Ontario
NOTL Drain Project Tender Results	DWG - SET	CAD		Municipal Drains and Irrigation Mapping	RECEIVED	PDF	2013-2025	11-2025	NOTL
NOTL Irrigation Reports	SPREADSHEET	COST SUMMARY		Tender Cost Summaries	RECEIVED	XLS		11-2025	NOTL
ABL	MAIN FOLDER	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ABL Expansion 2007-2010	PUBLICATION	TECHNICAL	Wiebe Engineering Group Inc. / K. Smart Associates Limited	Airport, Bright and Lavigne Municipal Irrigation System	RECEIVED	PDF	2000	09-2025	NOTL
ABL Expansion Investigation	PUBLICATION	TECHNICAL	Airport, Bright and Lavigne Municipal Irrigation System Expansion		RECEIVED	PDF	2007-2010	10-2025	NOTL
Four Mile	DWG - SET	CAD	Associated Engineering Limited	Airport, Bright and Lavigne Irrigation Systems Improvement	RECEIVED	PDF	2022-2023	11-2025	NOTL
Harrison-Roth	PUBLICATION	TECHNICAL	Wiebe Engineering Group Inc.	Four Mile Creek Municipal Irrigation System	RECEIVED	PDF	1997	09-2025	NOTL
Master Plan	PUBLICATION	TECHNICAL	Wiebe Engineering Group Inc.	Harrison Irrigation System	RECEIVED	PDF	1990-1995	09-2025	NOTL
Stantec 2006 to 2007 phase 1 and 2	PUBLICATION	TECHNICAL	Associated Engineering Limited	Town of Niagara on the Lake - Irrigation System Strategy & Master Plan	RECEIVED	PDF	2021	10-2025	NOTL
NOTL Municipal Drain Reports	PUBLICATION	TECHNICAL	Stantec	Raw Water for Agricultural Irrigation Study	RECEIVED	PDF	2005-2007	11-2025	NOTL
Airport Drainage System	MAIN FOLDER	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bright Drain and Bergman Branch	PUBLICATION / DWG - SET	TECHNICAL / CAD	Wiebe Engineering Group Inc.	Airport Municipal Drainage System - Watershed Plan	RECEIVED	PDF	1986	12-2025	NOTL
Cole Drain	PUBLICATION / DWG - SET	TECHNICAL / CAD	Wiebe Engineering Group Inc. / Young-Smart Engineering Company	Bright / Bergman Branch Municipal Drain	RECEIVED	PDF	1991	12-2025	NOTL
Four Mile Creek	PUBLICATION / DWG - SET	TECHNICAL / CAD	Wiebe Engineering Group Inc.	Cole Drain	RECEIVED	PDF	1991	12-2025	NOTL
Harrison Drainage System	PUBLICATION / DWG - SET	TECHNICAL / CAD	Wiebe Engineering Group Inc.	Four Mile Creek Municipal Drain	RECEIVED	PDF	1996	12-2025	NOTL
Lavigne Drain	PUBLICATION / DWG - SET	TECHNICAL / CAD	Wiebe Engineering Group Inc. / Young-Smart Engineering Company	Harrison Municipal Drain	RECEIVED	PDF	1989	12-2025	NOTL
MacDougall Drain	PUBLICATION / DWG - SET	TECHNICAL / CAD	Wiebe Engineering Group Inc.	Lavigne Municipal Drain	RECEIVED	PDF	1995	12-2025	NOTL
Routh Drain	PUBLICATION / DWG - SET	TECHNICAL / CAD	Wiebe Engineering Group Inc.	MacDougall Municipal Drain	RECEIVED	PDF	1987	12-2025	NOTL
Routh Drain Cass Branch	PUBLICATION / DWG - SET	TECHNICAL / CAD	Wiebe Engineering Group Inc.	Routh Drain	RECEIVED	PDF	1993	12-2025	NOTL
Thompson Drain	PUBLICATION	TECHNICAL	K-Smart Associates Limited	Routh Drain 2016	RECEIVED	PDF	2016	12-2025	NOTL
NOTL Watershed Plan	DWG - SET	TECHNICAL	Wiebe Engineering Group Inc.	Thompson Drain Watershed Plan	RECEIVED	PDF	1988 / 2001 / 2007	12-2025	NOTL
Open Data	GIS	GIS/CAD	Aquafor Beech Limited	Niagara Region Open Data Portal	RECEIVED	PDF	2005-2006	12-2025	NOTL
OPG Siphon	DWG - SET	CAD	Wiebe Engineering Group Inc.	OPG Siphon Plan and Profiles	RECEIVED	URL LINK	CURRENT	12-2025	RMR
Policies and Procedures	PROCEDURES	TECHNICAL		Startup Procedures, Operation Manuals	RECEIVED	PDF	2021	12-2025	NOTL
PTTW Files	BY-LAWS	REGULATORY		Permit to Take Water, Irrigation System Inspection Reports, etc	RECEIVED	DOC		12-2025	NOTL
Standards	PUBLICATION	REFERENCE	Niagara Region	CAD Standard, Project Design Manual	RECEIVED	PDF	2023-2025	12-2025	NOTL
Virgil Dams	PUBLICATION	TECHNICAL	Hatch Acres	CAD Standard, Project Design Manual	RECEIVED	URL LINKS	2025	12-2025	RMR
Water Availability Study (NPCA)	PUBLICATION	TECHNICAL	AquaResource Inc.	Virgil Dam - Safety Review, Operations & Maintenance Manuals	RECEIVED	PDF	2006	12-2025	NOTL
Websites	PUBLICATION	REFERENCE	Niagara Region	Water Availability Study for NOTL	RECEIVED	PDF	2009	12-2025	NPCA
Whirlpool Pump House	DWG - SET	CAD	Niagara Region	Planning & Economic Development, Project Charter	RECEIVED	URL LINKS	2025	12-2025	RMR
NOTL Official Plan.pdf	PUBLICATION	TECHNICAL	Niagara Region	Hydro Canal Pump House	RECEIVED	PDF	2002	12-2025	NOTL
DART Protocol	PUBLICATION	TECHNICAL	Ontario Government	Niagara on the Lake - Official Plan	RECEIVED	PDF	2024	12-2025	NOTL
Drainage Act	PUBLICATION	TECHNICAL	Ontario Government	DART Protocol Information	RECEIVED	URL LINK	CURRENT	12-2025	RMR
Eastchester Pump Impeller	IMAGE	TECHNICAL	Niagara Region	Drainage Act Information	RECEIVED	URL LINK	CURRENT	02-2026	RMR
Tree Map	GIS	GIS/CAD	NOTL	Eastchester Pump Impeller Photo	RECEIVED	JPG	2025	02-2026	NOTL
Irrigation Committee	PUBLICATION	TECHNICAL	NOTL	Witness Trees Program Interactive Map	RECEIVED	PDF	2024-2025	02-2026	NOTL
Elevation Mapping	GIS	GIS/CAD	Ontario Government	Financial Statements	RECEIVED	PDF	2002	12-2025	NOTL
Water Level Information	PUBLICATION	TECHNICAL	NOTL	Ontario Elevation Mapping Program	RECEIVED	URL LINK	CURRENT	02-2026	NPCA
Whirlpool	PUBLICATION	TECHNICAL	Niagara Region	Ops Water Levels, Grades & Elevations for Welland Canal	RECEIVED	XLS	2012	02-2026	NOTL
				NOTL Infrastructure (Whirlpool Area) - Transfer of Ownership	RECEIVED	PDF/TIF	2007	02-2026	NPCA

Individual Files Received

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NOTL Official Plan.pdf	2025-09-16 7:55	Gregorio, Miranda	2025-09-16 7:55	Gregorio, Miranda	Item
rpt_FINAL_System_Strategy_March_2021 (1).pdf	2026-02-23 6:47	Gregorio, Miranda	2026-02-23 6:47	Gregorio, Miranda	Item
3474-00 ABL Non Consolidated.doc	2025-09-05 10:48	brandon.enns@notl.com	2025-09-05 10:48	brandon.enns@notl.com	Item
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4220-08 Irrigation enforcement.pdf	2025-09-05 10:48	brandon.enns@notl.com	2025-09-05 10:48	brandon.enns@notl.com	Item
Bill Pr88.pdf	2025-09-05 10:48	brandon.enns@notl.com	2025-09-05 10:48	brandon.enns@notl.com	Item
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Proposed Changes to Section 7 subsection f.doc	2025-09-05 10:48	brandon.enns@notl.com	2025-09-05 10:48	brandon.enns@notl.com	Item
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B1286 Pumping Station Dee Rd - S1 - B Permit (May15,2017).pdf	2025-10-23 10:12	brandon.enns@notl.com	2025-10-23 10:12	brandon.enns@notl.com	Item
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Gordan Wright - Louvers, Dampers, Fans.pdf	2025-10-23 10:15	brandon.enns@notl.com	2025-10-23 10:15	brandon.enns@notl.com	Item
Goulds Pump Quote and Specifications.pdf	2025-10-23 13:04	brandon.enns@notl.com	2025-10-23 13:04	brandon.enns@notl.com	Item
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NC6197 REV2.pdf	2025-10-23 10:13	brandon.enns@notl.com	2025-10-23 10:13	brandon.enns@notl.com	Item
QPS-17-008 Report to Upgrade Dee Road Pump Station.pdf	2025-11-06 5:57	brandon.enns@notl.com	2025-11-06 5:57	brandon.enns@notl.com	Item
PumpOptimization_09Aug2017.pdf	2025-10-23 10:11	brandon.enns@notl.com	2025-10-23 10:11	brandon.enns@notl.com	Item
Quartek - Prelim Pump Station Layout April 2017.pdf	2025-11-06 7:37	brandon.enns@notl.com	2025-11-06 7:37	brandon.enns@notl.com	Item
Quartek - Revised Budget May 26 2017.pdf	2025-11-06 7:37	brandon.enns@notl.com	2025-11-06 7:37	brandon.enns@notl.com	Item
Quartek Preliminary Design Report and Quote (Dec 2016).pdf	2025-11-05 13:36	brandon.enns@notl.com	2025-11-05 13:36	brandon.enns@notl.com	Item
Sid Grabel Electrical Diagrams.pdf	2025-11-06 6:15	brandon.enns@notl.com	2025-11-06 6:15	brandon.enns@notl.com	Item
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Reserves, Debt, Capital Projects.pdf	2025-12-11 13:12	brandon.enns@nottl.com	2025-12-11 13:12	brandon.enns@nottl.com	Item
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Irrigation - 3 Year Historicals 2025.pdf	2025-12-11 13:08	brandon.enns@nottl.com	2025-12-11 13:08	brandon.enns@nottl.com	Item
John Deere Debenture.pdf	2025-12-11 13:08	brandon.enns@nottl.com	2025-12-11 13:08	brandon.enns@nottl.com	Item
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Kasper Land Drainage Quotation Submission.pdf	2025-11-17 13:42	Gregorio, Miranda	2025-11-17 13:42	Gregorio, Miranda	Item
Lavigne Municipal Drain Quotation NOTL-2019-ES-19001.pdf	2025-11-17 13:42	Gregorio, Miranda	2025-11-17 13:42	Gregorio, Miranda	Item
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Procedure_Carlton Street Siphons. PW.IRR.SOP_15.11.23.doc	2025-09-05 11:20	brandon.enns@nottl.com	2025-09-05 11:20	brandon.enns@nottl.com	Item
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Quartek Preliminary Design Report and Quote (Dec 2016).pdf	2025-11-17 13:44 Gregorio, Miranda	2025-11-17 13:44 Gregorio, Miranda	Item
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Kasper Land Drainage Quotation Submission.pdf	2025-11-14 6:49 brandon.enns@notl.com	2025-11-14 6:49 brandon.enns@notl.com	Item
Lavigne Municipal Drain Quotation NOTI-2019-ES-190001.pdf	2025-11-14 6:49 brandon.enns@notl.com	2025-11-14 6:49 brandon.enns@notl.com	Item
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06-044 Feasibility Study Report.pdf	2025-10-27 13:57 Gregorio, Miranda	2025-10-27 13:57 Gregorio, Miranda	Item
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ABL AMEC Geotech Report.PDF	2025-10-27 13:57 Gregorio, Miranda	2025-10-27 13:57 Gregorio, Miranda	Item
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ABL Wetland Supply Comments.pdf	2025-10-27 13:57 Gregorio, Miranda	2025-10-27 13:57 Gregorio, Miranda	Item
Irrigation Committee Presentation March 1, 2007(no animation).ppt	2025-10-27 13:57 Gregorio, Miranda	2025-10-27 13:57 Gregorio, Miranda	Item
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Let from NPCA re ABL 16Oct2007.pdf	2025-10-27 13:57 Gregorio, Miranda	2025-10-27 13:57 Gregorio, Miranda	Item
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Notice to Residents for Control Structure Replacement.pdf	2025-10-27 13:57 Gregorio, Miranda	2025-10-27 13:57 Gregorio, Miranda	Item
NPCA ABL Requirements.PDF	2025-10-27 13:57 Gregorio, Miranda	2025-10-27 13:57 Gregorio, Miranda	Item
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90188342.pdf	2025-12-03 6:13	Gregorio, Miranda	2025-12-03 6:13	Gregorio, Miranda	Item
NOTL - ABI_4410-8BNQWF.pdf	2025-09-24 13:23	Gregorio, Miranda	2025-09-24 13:23	Gregorio, Miranda	Item
NOTL-Four Mile Creek5846-8EXP84.pdf	2025-09-24 13:23	Gregorio, Miranda	2025-09-24 13:23	Gregorio, Miranda	Item
NOTL-Harrison8132-8BNN6K.pdf	2025-09-24 13:23	Gregorio, Miranda	2025-09-24 13:23	Gregorio, Miranda	Item
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Water Taking Residents - 2015.xlsx	2025-09-24 13:24	Gregorio, Miranda	2025-09-24 13:24	Gregorio, Miranda	Item
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Appendix B.

Appendix B. Irrigation User Survey

Niagara Irrigation Initiative Project: Upgrading Irrigation Infrastructure in NOTL

We want to hear your ideas, suggestions and opinions!

Please complete this feedback form so your valued input can be considered and documented as part of the Upgrading and Enhancing Irrigation Infrastructure in the Town of Niagara-on-the-Lake project. Your participation in this survey is voluntary. All individual responses will be kept confidential and will be used only for the purposes of helping to develop the Project. Non-identifiable summaries of responses may be developed and shared publicly.

This survey will take approximately 5 to 10 minutes to complete and will be available for the next four weeks.

When you submit this form, it will not automatically collect your details like name and email address unless you provide it yourself.



1. Name (*open response*)
2. Email Address (*open response*)
3. Mailing Address (*open response*)
4. Roll Numbers or Municipal Address of Irrigated Parcels (*open response*)
5. Telephone Number (*open response*)
6. Which irrigation service area are you connected to? (*multiple answers*)
 - Harrison Routh
 - Four Mile Creek
 - Airport-Bright Lavigne
 - Lake Ontario/Niagara River
 - Unknown
 - Other (*open response*)
7. How close is the irrigation water source to your property? (*single choice*)
 - Less than 100m
 - 100m to 250m
 - 250m to 500m
 - 500m or more

NOTICE:

This is an initial alignment. The final alignment is done after the unit has been run under actual operating conditions. The final alignment procedure is outlined in [5.21 Final Alignment on page 55](#) and must be followed. Make sure: motor starting switch is "locked out" to prevent accidental rotation.

Any coupling manufacturer's instruction sheets, sent with the pump, should be studied and used when installing, aligning, or servicing coupling. Note that coupling hubs are not necessarily mounted flush with the shaft ends.

If instructions are not available, the following procedure may be used. The procedure is given for two basic coupling types:

1. Flexible Coupling - Normally furnished on all units except "back pull-out". Normally not assembled (except "spider-insert" type which are preassembled) .
2. Flexible Spacer Coupling - Furnished as standard on all "back pull-out" units. Contains a removable spacer piece located between coupling hubs.

NOTICE:

Note that alignment in one direction may alter alignment in another. Check through each alignment procedure after making any alignment alteration.

4.5.1.1 Parallel Alignment

1. Unit is in parallel misalignment when the shaft axes are parallel but not concentric. Shift driver as required.
2. In order to obtain vertical parallel alignment under actual operating conditions, the driver shaft may have to be set higher or lower (using thin shim stock) than the pump shaft due to differences in expansion rates. Pump expansion rates vary with pump design. The following is a suggested cold setting for motor driven units:

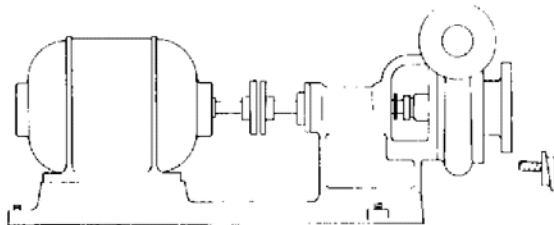


Figure 19: Frame Mounted Units

Option	Description
Pumpage Temperature	Set
Above Ambient	Motor
Temperature	Shaft

Option	Description
Ambient	0.102mm - 0.152mm 0.004" - 0.006" Low
38°C 100°F	0.051mm - 0.102mm 0.002" - 0.004" Low
93°C 200°F	0.000mm - 0.051mm 0.000" - 0.002" Low
149°C 300°F	0.000mm - 0.051mm 0.000" - 0.002" High

- Cash crops
 - Golf course
19. If you had access to more water, would you switch your type of irrigation? (*single choice*)
- Yes
 - No
20. Do you have any questions about the project? (*open response*)

We appreciate the time you have taken to learn about our plans and contribute your input.
If you have any questions, comments or would like to be added to the project mailing list, contact us:

Sean Norman, PMP, MCIP, RPP
Senior Planner, Niagara Region
905-980-6000 extension 3179
sean.norman@niagararegion.ca

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Appendix C.

DRAFT

AECOM

NOTL Irrigation Infrastructure Detailed Design

Irrigation Water Requirements

Project Number: 60757321

2026

Delivering a better world

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- may be based on information provided to AECOM which has not been independently verified;
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued;
- must be read as a whole and sections thereof should not be read out of such context;
- was prepared for the specific purposes described in the Report and the Agreement; and
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Quality Information

Prepared by

Pierre Roy, M.Sc.

Lead Irrigation Engineer

Checked by

Rohan Hakimi, M.A.Sc., P.Eng.

Irrigation Engineer

Miranda Gregorio

Deputy Project Manager/Project Engineer

Neal Morris

Civil Engineer

Verified by

Pippy Warburton, P.Eng.

Project Manager

Distribution List

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Prepared for:

Niagara Region

Prepared by:

Pierre Roy, P.Eng.

AECOM Canada ULC
85 West St-Catherine
Montreal, QC H2X 3P4
Canada

T: 514.946.2621
aecom.com

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Table of Contents

Executive Summary

1. Introduction.....	1
1.1 Project Background and Context	1
1.2 Objective and Design Parameters	1
2. Background Study Review and Grower Input	3
2.1 Background Study Scope	3
2.2 Historical Demand Metrics and Service Level Target.....	3
2.3 Water Consumption Methodology, Efficiency, and Constraints	3
2.4 Master Plan Upgrades and User Requirements	5
3. Methodology and Design Parameters	6
3.1 Establishing Service Level and Agronomic Parameters	6
3.2 Defining Efficiency and Gross Water Requirement.....	6
4. Net and Gross Water Requirements for the Critical Period.....	7
4.1 Modelling Software and Precipitation Data	7
4.2 Result Comparison with Background Studies.....	8
4.3 Service Targets	9
5. Volumetric Flow Rate Calculation and Hydraulic Network Sizing.....	10
5.1 Design Demand Parameters	10
5.2 Integration of GIS Data	10
5.3 Volumetric Calculation	10
5.4 Hydraulic Sizing and Operational Constraints	10
5.4.1 Current Pumping Volumes and Asset Capacity	11
5.4.2 Regulatory and Environmental Constraints	11
5.4.3 Operational Limitations and Bylaws	11
5.4.4 Sizing the infrastructure for the Gross Irrigation Requirements	12
6. Next Steps: Integration of Scheduling and Hydraulic Modelling.....	13
6.1 Hydraulic Modelling for Final Sizing.....	13
6.2 Integration of Operational Scheduling	13
6.3 Final Reliability and Pressure Guarantee	13

Tables

Table 1: Efficiencies of Various Irrigation Techniques (Stantec, 2007)	4
Table 2: Monthly precipitations for 5- and 10-year drought period	7
Table 3: Net irrigation requirements (NIR).....	8
Table 4: Gross irrigation requirements (GIR).....	9
Table 5: Comparison of Daily Average Gross Demand (mm/day)	9
Table 6: Volumetric results (at pumping stations)	11

Appendices

Appendix A.	CROPWAT Model Input and Results
Appendix B.	GIS Analysis Figures
Appendix C.	Volumetric Results

Executive Summary

This technical memorandum defines the water requirements for the Niagara-on-the-Lake (NOTL) Irrigation Infrastructure Detailed Design (RFP-81). The primary objective is to bridge the significant gap between current supply capacities and the peak demands required to sustain high-value crops during severe drought conditions, established as a 1-in-10-year drought event.

Refined Peak Irrigation Demands

The design is anchored by a target Level of Service (LOS) of 51 mm of net irrigation water over a 14-day period¹. To determine the actual volume required at the pumping stations, an overall system efficiency of 56% was applied, accounting for a 70% conveyance efficiency in open channels and an 80% on-farm application efficiency. Based on CROPWAT² modeling package and the FAO-56 methodology³, the final Gross Irrigation Requirements (GIR) for peak daily demand are:

- Vineyards: 4.9 mm/day
- Orchards: 6.5 mm/day
- Greenhouses: 10.0 mm/day
- Nurseries: 21.1 mm/day
- Golf Course: estimated to 7.8 mm/day

Volumetric Demand and 10-Year Projections

The integration of GIS data and agricultural profiling identifies a substantial immediate and future water deficit. The total daily volume required to satisfy current producers during a 10-year drought exceeds the existing physical and regulatory capacities of the three primary systems (ABL, FMC, and HR).

- **Current Volumetric Requirement:** The total gross water volume requirement is estimated at 185,126 m³/day including integration of new irrigation sectors (Eastchester and Dee Road, see Appendix B Figures 2 and 3 respectively)
- **10-Year Horizon Projection:** With an improved system and anticipating a possible 30% increase in irrigation permits and agricultural intensification, the demand is projected to reach 240,665 m³/day within 10 years.

System Capacity Comparison and Infrastructure Gaps

The existing pumping assets are currently incapable of meeting these drought demands. The current pumping capacities are summarized as follows:

- Airport-Bright Lavigne (ABL): Total supply of 25,344 m³/day (Eastchester PS and Carlton Siphons).
- Harrison/Routh (HR): Theoretical allowable rate of 66,643 m³/day (Dee Road PS and OPG Siphon).
- Four Mile Creek (FMC): Highly constrained at 6,540 m³/day (Whirlpool PS).

The total theoretical current supply capacity of approximately 98,527 m³/day represents only 53% of the immediate peak demand and less than 41% of the 10-year projected demand.

¹ Associated Engineering (Ont.) Ltd. (2021). Town of Niagara-on-the-Lake Irrigation System Strategy & Master Plan. Prepared for the Town of Niagara-on-the-Lake.

² Food and Agriculture Organization of the United Nations (FAO). CROPWAT 8.0 for Windows. FAO Land and Water Development Division, Rome.

³ Allen, R. G., Pereira, L. S., Raes, D., & Smith, M. (1998). Crop evapotranspiration - Guidelines for computing crop water requirements - FAO Irrigation and drainage paper 56. Food and Agriculture Organization of the United Nations, Rome.

Strategic Recommendations

To satisfy the target LOS and manage these volumes, the following infrastructure upgrades are mandatory: doubling the capacity of Eastchester PS, adding a second pump at Whirlpool PS, and installing a third pump at Dee Road PS to supplement the FMC system through new interconnections. Furthermore, as the instantaneous demand required to satisfy all users simultaneously would far exceed channel capacities and Permit to Take Water (PTTW) limits, the implementation of coordinated irrigation scheduling and rotation is essential for system viability.

1. Introduction

This technical memorandum describes the scope and context of the engineering analysis required for the Niagara Irrigation Initiative Project: Upgrading and Enhancing Irrigation Infrastructure in the Town of Niagara-on-the-Lake (NOTL). This assignment focuses on optimizing the performance and ensuring the long-term sustainability of the Town's existing irrigation infrastructure.

1.1 Project Background and Context

The Town of Niagara-on-the-Lake is situated on favorable agricultural lands and surrounded by significant water sources including Lake Ontario, the Niagara River, the Welland Canal, and Ontario Power Generation (OPG) reservoirs. Agriculture, specifically tender fruit and grape growing, is central to the Town's identity and critical to its economic well-being; the agriculture in this area is also interlinked with the local tourism industry.

The necessity for this initiative is underscored by the impacts of climate change, such as drought conditions, which highlight the need for improved and resilient irrigation infrastructure across the Region. The drought in 2016 severely affected the agricultural community, demonstrating that the existing open channel system was inadequate to meet the needs of all irrigators during periods of high demand.

The existing NOTL irrigation system operates as a municipal utility utilizing a network of open channels and municipal drains to convey raw water supplied by five intake locations (pumps and siphons) drawing from the Welland Canal, Niagara River, and OPG facilities. The system is managed by the Town's Public Works Department, with oversight from the Irrigation Advisory Committee, in a long-standing public-private partnership model.

This Assignment is mandated by the Town's 2021 Irrigation System Strategy and Master Plan⁴ - here on referred to as "Master Plan". This Master Plan aims to improve customer levels of service, ensure long-term growth and sustainability, and achieve a state-of-good-repair of the Town's infrastructure.

1.2 Objective and Design Parameters

The primary objective of this assignment is to implement the Master Plan by updating and consolidating the Town's existing engineering reports and undertaking the necessary detailed design work of the preferred upgrades.

The focus of the work is concentrated on upgrading and enhancing the existing infrastructure within the three primary delivery areas: Harrison/Routh (HR), Four Mile Creek (FMC), and Airport-Bright Lavigne (ABL).

Key goals for the project deliverables include⁵:

- **Service Level Goal:** Achieving the ultimate level of service required by existing irrigators, defined as supplying a minimum of 51 mm of irrigation water over a two-week period during drought conditions.
- **System Capacity:** Designing elements necessary to increase the capacity of all three systems to address existing shortages, such as doubling the capacity of the Eastchester Pumping Station and installing a third pump at Dee Road Pumping Station.
- **System Reliability:** Ensuring security of supply by addressing aging infrastructure (e.g., OPG Siphon condition assessment) and considering interconnection options between the three systems.

⁴ Associated Engineering (Ont.) Ltd. (2021). Town of Niagara-on-the-Lake Irrigation System Strategy & Master Plan. Prepared for the Town of Niagara-on-the-Lake.

⁵ Regional Municipality of Niagara. (2025). Request for Proposals No. 2025-RFP-81: Niagara Irrigation Initiative Project: Upgrading and Enhancing Irrigation Infrastructure in the Town of Niagara-on-the-Lake. Thorold, ON: Niagara Region.

- Implementation: Preparing engineering design drawings and tender documents for the selected upgrades.
- Timeline: The work plan and detailed schedule must demonstrate completion of the assignment by the end of 2026.

The overall project will require technical rigor, hydraulic capacity analysis, and a comprehensive engagement program to align stakeholders around the shared vision for upgrading the existing communal system.

2. Background Study Review and Grower Input

2.1 Background Study Scope

The scope of this assignment requires the comprehensive review and consolidation of three older engineering reports (from the late 1990s and early 2000s) for the Airport-Bright Lavigne (ABL), Four Mile Creek (FMC), and Harrison/Routh (HR) systems. The three systems were created by municipal by-law uses Bill PR 88 “respecting the Town of Niagara-on-the-Lake Act”. These foundational documents require updating to reflect current conditions and the specific enhancements detailed in the Master Plan.

2.2 Historical Demand Metrics and Service Level Target

The need for system enhancement is primarily driven by recent climate change impacts, notably the severe drought experienced in 2016, which highlighted the inadequacy of the existing system to meet the demands of all irrigators.

The core service gap is defined by the contrast between peak demand and inadequate supply:

- **Service Level Goal:** As indicated above, the Master Plan established that the ultimate level of service requires the system to be capable of providing a minimum of 51 mm of irrigation water over a two-week period to sustain crops during a severe drought.
- **Grower Reported Consumption:** During severe drought periods, farmers have reported taking between 77 mm and 102 mm of water (3 to 4 inches) over a two-week span to maintain crop health⁶.
- **Historical Peak Demand:** Earlier feasibility studies for the region established peak day demands at the farm gate of approximately 5.0 mm/day for tender fruits and 4.6 mm/day for grapes. Historically, maximum irrigation demand typically peaks during July and August⁷.

In preparation of this report, the target level of service of 51 mm of irrigation over a two-week span, as a minimum, will be rigorously verified through an updated analysis of climate data and crop requirements specific to the NOTL region.

2.3 Water Consumption Methodology, Efficiency, and Constraints

The methodology for meeting the required service level is constrained by the nature of the existing system and regulatory limits:

- **Infrastructure Condition and Conveyance Efficiency:** Site assessments and grower surveys confirm that conveyance capacity is negatively impacted by the condition of the open channels, including sedimentation, blockages, and Phragmites invasion. Furthermore, culverts conveying flow are sometimes under-sized, creating bottlenecks that restrict maximum flow conveyance during high demand periods. The existing irrigation system is prone to water losses through evaporation and seepage. Early studies assessed the conveyance efficiency for NOTL open channels during peak periods to be as low as 40%. Increasing this efficiency up to 70% is considered acceptable in the context of the current conveyance system and the objective of the project⁸.
- **Field Irrigation Efficiency:** The efficiency achievable by modern pressurized drip systems is up to 84%.
- **Regulatory Constraints (PTTW):** The Town’s existing Permit to Take Water (PTTW) allowances have not been reviewed since 2013 and will likely need to be increased to keep up with present

⁶ Associated Engineering (Ont.) Ltd. (2021). Town of Niagara-on-the-Lake Irrigation System Strategy & Master Plan. Prepared for the Town of Niagara-on-the-Lake.

⁷ Stantec Consulting Ltd. (2005). Feasibility Study – Raw Water for Agricultural Irrigation Purposes Project Report. Prepared for the Regional Municipality of Niagara.

⁸ Stantec Consulting Ltd. (2007). Niagara Feasibility Phase 2 Engineering Report. Prepared for the Regional Municipality of Niagara.

and future demand, particularly considering climate change impacts. The successful completion of this Assignment requires providing technical assistance for any necessary PTTW amendments.

- **Operational Constraints:** Municipal noise bylaws currently prohibit farmers from operating pumps for twenty-four hours a day, which significantly limits the system's ability to meet peak demand during droughts.

The detailed Water Consumption Study (Stantec, 2007) refined the inputs necessary for calculating irrigation requirements.

- **Crop coefficients:** Based on research and field measurements for standard management practices in the Region (permanent sod with herbicide strips), the recommended crop coefficients for calculating plant water use (ET_c) were:
 - Peaches (Tender Fruit): 1.0 for July and August, and 0.95 for September.
 - Grapes: 0.8 for July and August, and 0.65 for September.
- **Delivery efficiency:** Although early studies assessed the conveyance efficiency for open channels during peak periods can reach approximately 40-60%, this percentage must be increased to 70% with a rehabilitated conveyance system.
- **Global efficiency:** The delivery efficiency combined with the field distribution efficiency give the Global efficiency.

Previous study provides a breakdown of detailed efficiencies based on various irrigation technologies and is summarized **Table 1** below. A column is added with the resulting global efficiency.

Table 1: Efficiencies of Various Irrigation Techniques (Stantec, 2007)

Irrigation Technique	Average Distribution Efficiency	Efficiency Range (Published)	Average Delivery Efficiency	Average Global Efficiency*	Contextual Information
Micro (Drip) Irrigation	84 %	70 % to 95 %, reaching up to 98 %	70%	60 %	Considered the most efficient system. Micro-irrigation uses roughly 20% of the water and fuel compared to overhead systems in vineyards per cycle.
Overhead Irrigation (General)	Above 80 %	N/A		Above 56 %	High-efficiency overhead systems exist.
Overhead/Traveling Gun Irrigation	68 %	50 % to 75 %		47 %	Considered the least efficient due to susceptibility to water losses from wind, evaporation, and non-uniform application.
On-Farm Efficiency (Feasibility Study Baseline)	80 %	N/A		56 %	Proposed as the efficiency rate for calculating peak demands at the farm gate in the 2005 feasibility study.

* AECOM added.

- **Drought scenario:** For the seasonal analysis, calculations were performed for both average precipitation conditions and a severe drought condition (1-in-10 and 1-in-5-year return drought), evaluating the increased requirements during extreme years.

2.4 Master Plan Upgrades and User Requirements

The solutions proposed in the Master Plan and detailed in the RFP-81 scope reflect a consensus on the essential upgrades required to achieve the service target:

- **Pumping Capacity Increases:** Key upgrades include doubling the capacity of the Eastchester Pumping Station to 8 000 gpm and determining the necessary steps to retrofit the Dee Road Pumping Station to accommodate the installation of a third pump.
- **Infrastructure Reliability and Expansion:** The work must address the poor condition of existing assets, including the OPG Reservoir Siphon (Harrison-Routh) and the dam structure/reservoirs within the Four Mile Creek System (Virgil Ponds), potentially involving acquisition or reconstruction. Expansion routes and storage opportunities (reservoirs) must also be identified.
- **System Interconnection:** The design must consider interconnecting the three systems (ABL, FMC, HR), notably routing flow from the Dee Road PS to supplement the Four Mile Creek system, to ensure security of supply.
- **Operational Tools:** Crucially, the plan mandates the implementation of irrigation scheduling/rotation strategies to manage demand equitably, coupled with the installation of flow meters at the farm gate to ensure accountability and promote water conservation.

3. Methodology and Design Parameters

The planning for the upgrades to the NOTL system requires adopting a clear and operationally relevant metric to define the system's required capacity. The background work for the Niagara-on-the-Lake (NOTL) system includes a minimum 14-day irrigation requirement of 51mm. This value was rigorously checked using an updated methodology to ensure reliable service delivery during critical drought periods, as outlined below.

3.1 Establishing Service Level and Agronomic Parameters

The updated methodology aimed to refine the water requirements by aligning modern agronomic standards with the expected level of service during extreme conditions:

- **Ten-day service target** - The design is anchored by the service objective established in regional planning documents (e.g., the Master Plan). This objective stipulates that the irrigation infrastructure must be capable of providing a minimum of 51 mm of irrigation water over a two (2) week period to sustain crops in the NOTL area during a severe drought. This two-week period aligns closely with the ten-day concept commonly used in water resource planning. A ten-day target must be determined for the specific crop pattern in this review. This calculation is outlined in Section 4 below.
- **Crop coefficients** - Accurate water requirements were determined using the relationship between crop water use (ET_c) and the reference evapotranspiration (ET_0) through the application of specific crop coefficients (K_c). The selection of K_c values is based on earlier research and field measurements for standard management practices in the Region, notably permanent sod with herbicide strips. The K_c coefficient for July and August (the critical demand period) were adopted for calculation of the gross and net water demands to a K_c value of 1.0 for orchard and 0.8 for vineyard.
- **Greenhouses and nurseries** - To align the design methodology across all high-value crops, the peak water demand at farm gate for greenhouses and nurseries is 7.0 mm/day and 14.8 mm/day, respectively. For greenhouses, this value corresponds to the peak demand for flower production in July. It should be noted that the nursery demand represents the maximum requirement for container nursery production, which requires intensive irrigation.
- **Golf Courses** – Crop coefficients (K_c) for golf courses typically range from 0.5 to 1.0, varying significantly by grass type with cool-season grasses often using 0.8 and warm-season grasses around 0.7 in standard models, but dynamic scheduling can use lower values (0.5-0.8) during cooler periods, and even higher for stressed areas or specific grass types. Because looking at K_c under high water stresses in drought conditions, the K_c value of 1.0 is adopted.

3.2 Defining Efficiency and Gross Water Requirement

To translate the estimated net agricultural demand into the required raw water volume (Gross Irrigation Requirement - GIR), the efficiency of both the farm application and the system conveyance must be accounted for.

- **Irrigation efficiency** - The overall irrigation efficiency was set to 56 % for the calculation of the GIR. This value reflects the efficiency of 70 % for the canal conveyance system combined with the average distribution efficiency at farm level (On-Farm Efficiency of 80 %). This overall efficiency level is consistent with published data which typically range from 60 % to 80 % for open channel irrigation schemes. This efficiency factor directly affects the final sizing, as the total volume of water that must be pumped and conveyed by the system is calculated as: $Gross = Net \div Efficiency$.

4. Net and Gross Water Requirements for the Critical Period

This section presents the refined water demand estimations derived for this memo, focusing on the critical period of peak irrigation demand in a design drought scenario. These calculations establish the volumetric requirements essential for the hydraulic sizing of the new communal pressurized pipe network in the NOTL Irrigation System.

4.1 Modelling Software and Precipitation Data

The refinement of these estimations employed the standard CROPWAT modelling software⁹ (**Appendix A**), based on the FAO-56 methodology¹⁰, which is explicitly designed for planning irrigation schemes and calculating water budgets on a 10-day basis. This process relies on calculating the evapotranspiration of crops (ET_c) and the soil water balance.

These refined calculations leveraged historical meteorological data, specifically utilizing the Environment Canada “Vineland” weather station located in Lincoln (ID 31367) for 2003–2024. This relatively short period is used to give more effect of climate change impact in the last years. The estimation of monthly drought returns levels for 5- and 10-year periods is based on a curvefitting- approach implemented with R package eXtreme. The Generalized Extreme Value (GEV) distribution was fitted to the monthly drought metric. The fitted GEV model was then used to derive return levels for the 5- and 10-year return periods. It should be noted that generally the 5-year drought condition is used for irrigation design but given the value of the crops in question, the 10-year drought condition is being used (see **Table 2**).

Table 2: Monthly precipitations for 5- and 10-year drought period

Month	5 year drought period (mm)	10 year drought period (mm)
January	38.5	31.4
February	39.7	32.1
March	34.5	24.4
April	49.5	39.8
May	32.2	23.9
June	40.9	29.9
July	42.0	31.8
August	45.6	35.5
September	35.7	28.3
October	49.1	38.9
November	34.5	26.3
December	46.4	39.7

The design capacity of the irrigation system must be based on the maximum water deficit expected during a severe drought year, aligning with modern agronomic standards and regional service objectives.

- **Drought scenario:** The analysis is predicated on calculating the demand during the critical peak period, specifically centered around the second and third periods of July, corresponding to the

⁹ Food and Agriculture Organization of the United Nations (FAO). CROPWAT 8.0 for Windows. FAO Land and Water Development Division, Rome.

¹⁰ Allen, R. G., Pereira, L. S., Raes, D., & Smith, M. (1998). Crop evapotranspiration - Guidelines for computing crop water requirements - FAO Irrigation and drainage paper 56. Food and Agriculture Organization of the United Nations, Rome.

summer drought recurrence. Historical data confirmed that the onset of irrigation typically occurred in July after a period of prolonged dryness.

- **Service level target:** Recent regional planning in the NOTL area established that the ultimate level of service requires the system to provide a minimum of 51 mm of irrigation water over a two (2) week period to sustain crops during a severe drought. A specific value is calculated below for the NOTL area. This two-week temporal dimension aligns with the ten-day analytical framework used for scheduling and operational planning.
- **Agronomic inputs:** The calculation utilizes established crop coefficients (K_c) for July and August peak period of 1.0 for orchard and 0.8 for vineyard, based on local field measurements and permanent sod practices (see section 2.3 above).

4.2 Result Comparison with Background Studies

The net and gross irrigation requirements for the critical 5- and 10-day periods were estimated and are discussed below:

- **Net irrigation requirement (NIR):** Calculations based on crop evapotranspiration (ET_c) and minimal effective precipitation during the design drought period resulted in a NIR presented in **Table 3** below (for model details, see **Appendix A** for CROPWAT results). With peak demand at end of July, the net water use over a 10-day period for vineyard and orchard can be respectively estimated at 24.2 mm and 33.6 mm for 5-year drought and at 27.2 mm and 36.6 mm for 10-year drought period.

Table 3: Net irrigation requirements (NIR)

Metric	Calculated Value (10 day peak) (Present AECOM Study)		10 day Peak Demand ^a
	5 year drought	10 year drought	
Net irrigation requirement (NIR) for vineyard	24.2 mm	27.2 mm	37 mm ^b
Net irrigation requirement (NIR) for orchard	33.6 mm	36.6 mm	40 mm ^b
Net irrigation requirement (NIR) for greenhouses	-	-	56 mm ^c
Net irrigation requirement (NIR) for nurseries	-	-	118 mm ^c
Net irrigation requirement (NIR) for golf courses	33.6 mm	36.6 mm	-

^a Derived from day peak demand in Stantec Reports 2005¹¹

^b From section 2.2: high of water at farm gate multiplied by on-farm irrigation efficiency (80 %)

^c From section 3.1: high of water at farm gate multiplied by on-farm irrigation efficiency (80 %)

- **System efficiency:** To translate the necessary net volume into the total raw water volume required for pumping, an overall system efficiency was applied. An efficiency of 56% was used, consistent with the expected performance of channel water conveyance system with sprinkler/canon and drip irrigation averaged system (see **Table 1**).
- **Gross Irrigation Requirement (GIR):** Applying the global efficiency to the NIR results in a GIR of 43.2 mm and 60.0 mm per ten-day period respectively for vineyard and orchard for 5-year drought period and 48.6 mm and 65.4 mm for a 10-year drought period. Over a two-week (14-day) period, the calculated gross requirement is 60.5 mm and 84.0 mm respectively for vineyard and orchard for a 5-year drought period and 68 mm and 91.6 mm for a 10-year drought period (see **Table 4**).

¹¹ Stantec Consulting Ltd. (2005). Feasibility Study – Raw Water for Agricultural Irrigation Purposes Project Report. Prepared for the Regional Municipality of Niagara.

Table 4: Gross irrigation requirements (GIR)

Metric	Calculated Value for 10 day period		Calculated Value for 14 day period	
	5 year drought	10 year drought	5 year drought	10 year drought
Gross irrigation requirement (GIR) for vineyard	43.2 mm	48.6 mm	60.5 mm	68.0 mm
Gross irrigation requirement (GIR) for orchard	60.0 mm	65.4 mm	84.0 mm	91.6 mm
Gross irrigation requirement (GIR) for greenhouses	100 mm		140 mm	
Gross irrigation requirement (GIR) for nurseries	211 mm		295 mm	
Gross irrigation requirement (GIR) for golf courses ^a	71.5 mm	77.9 mm	100.1 mm	109.06 mm

^a A global irrigation efficiency of 0.47% is used for golf courses (see Table 1).

4.3 Service Targets

The newly derived requirements must be compared to and validated against prior studies and established service levels to ensure they reflect the scale needed for modern system design.

The calculated average daily gross demands align closely with the peak design requirements determined in the Master Plan as shown below in **Table 5**.

Table 5: Comparison of Daily Average Gross Demand (mm/day)

Metric	Calculated Value (10 year drought) (Present AECOM Study)	Stantec Studies Peak Day Demands (2005) ^a
Daily Gross Demand for vineyard	4.9 mm/day	6.6 mm/day
Daily Gross Demand for orchard	6.5 mm/day	7.1 mm/day

^a From 2.2 : Water depth required at farm divided by the conveyance efficiency in channels.

The calculated daily gross irrigation rate of 4.9 mm/day for vineyards represents 75% of the previous Stantec estimation (2005), while for orchards, it represents 92%. At this stage, it is essential to note that the historical figures of 4.6 mm/day for grapes and 5.0 mm/day for tender fruit (see Section 2.2) were estimations of peak irrigation demands at the farm gate. These values were derived by applying a standard 80% on-farm irrigation efficiency to the estimated peak average daily water use for mid-July.

Previous studies estimated that the seasonal water requirement for peaches using drip irrigation during a 1-in-10-year drought was 232.3 mm, while the requirement for grapes was 101.3 mm. In comparison, the FAO model, the international standard for water demand determination, calculates requirements of 405.5 mm and 294.2 mm, respectively, based on updated precipitation data for a 10-year drought return period.

As the minimum service target established in regional planning documents (e.g., Master Plan) is 51 mm (NIR) over a two-week period, the resulting GIR at the head of the irrigation scheme is 91 mm, or 6.5 mm/day. This service target for orchards is confirmed through CROPWAT analysis; however, for vineyards, the updated model indicates a requirement of only 4.9 mm/day.

Based on **Table 4**, for greenhouses and nurseries, the daily GIR are 10.0 and 21.1 mm respectively.

5. Volumetric Flow Rate Calculation and Hydraulic Network Sizing

This section details the critical process of converting the calculated Gross Irrigation Requirements (GIR), expressed in depth (mm) into volumetric flow rates (cubic meters) for the hydraulic modeling phase of this project design. This conversion is essential to confirm that the estimated demands of the NOTL irrigation system is compatible with the proposed fixed design capacity and to define the precise sizing required for the pumping stations and the various hydraulic structures of the irrigation systems.

5.1 Design Demand Parameters

The quantification of the design demand for hydraulic modelling relies on the refined GIR established in the analysis above:

- **Gross Irrigation Requirements (GIR):** The system is sized to deliver 4.9, 6.5, 10.0, 21.1 mm and 7.8 per day respectively for vineyard, orchard, greenhouse, nursery and golf course in a peak demand period. This figure represents the total raw water volume required, accounting for losses.
- **Design Drought Scenario:** This requirement is derived from calculations corresponding to the critical period (third 10-day periods of July) during a ten-year recurrence drought.
- **System Efficiency:** The Gross Irrigation Requirement incorporates an overall system irrigation efficiency of 56 % (80 % for on-farm distribution and 70 % for system conveyance) reflecting the standard performance expected from channels distribution system with on-farm pressurized technologies with a mix of drip system, water canon and sprinkler irrigation technologies). For golf course, an overall system irrigation efficiency of 47 % is adopted.

5.2 Integration of GIS Data

To ensure accurate translation of water depth requirements (mm) into flows (cubic meters) for specific locations within the infrastructure network, the design utilizes precise spatial and agricultural data through GIS integration. GIS figures illustrating the study areas, encompassing currently irrigated lands, the proposed Dee Road expansion zone, and the new Eastchester service area, along with cultivation parcels and the planned irrigation channel networks and connections, are provided in **Appendix B**.

GIS was used to identify all agricultural parcels that will be serviced in the three districts, specifically tracking the high-value crops: Vineyard (Grapes), Orchard (Tender Fruit), Greenhouses, Nurseries and Golf Course. This work involved mapping these parcels and estimating the intake position for each parcel.

5.3 Volumetric Calculation

The GIS database, which incorporates parcel areas and the established GIR (mm), allows for the direct calculation of the total volumetric water needs for every individual intake and subsequently for every segment of the NOLT irrigation channel network (see **Appendix C**). Total volumetric results at intakes are presented in **Table 7**.

5.4 Hydraulic Sizing and Operational Constraints

The sizing of upgrades for the NOTL irrigation system is dictated by the requirement to bridge the significant gap between current supply capacities and the peak demands experienced during 10-year return period drought calculated in the current report (see Section 5.1). This analysis considers existing pumping volumes, regulatory limits, and municipal bylaws that restrict optimal system performance.

Table 6: Volumetric results (at pumping stations)

Group	Current Gross Water Volume Requirement (m ³ per day)	Gross Water Volume Requirement at Project Completion (m ³ per day)	10 Years Horizon Anticipated Gross Water Volume Requirement (m ³ per day)
Current Area - Producers with permits	167 859	167 859	218 217 ^a
New East Area – Dee Road	-	2 755 ^b	3 582 ^c
New West Area - Eastchester	-	14 512 ^b	18 866 ^c
Total		185 126	240 665

^a Under the current irrigation scheme, producers holding a permit represent 54% of all producers. A 30% increase in this number is expected over a 10-year horizon.

^b In new areas, only current vineyard, orchard, greenhouse, nursery and golf courses are considered.

^c A 30% increase is expected over the 10-year horizon.

5.4.1 Current Pumping Volumes and Asset Capacity

The existing system relies on five primary intake locations. Based on the Master Plan, the current allowable and asset capacities are summarized as follows:

- Airport-Bright Lavigne (ABL): The Eastchester Pumping Station currently provides 21,804 m³/day. This is supplemented by the Carlton Siphons, which add approximately 3,540 m³/day.
- Harrison/Routh (HR): The Dee Road Pumping Station operates two pumps with a combined allowable rate of 27,255 m³/day, although the asset itself has a theoretical capacity of 49,200 m³/day. The OPG Reservoir Siphon provides an additional 17,443 m³/day when operational.
- Four Mile Creek (FMC): This system is the most constrained, with the Whirlpool Pumping Station providing only 6,540 m³/day.

The theoretical total current supply capacity of approximately 98,527 m³/day represents only 53% of the immediate peak demand and less than 41% of the 10-year projected demand.

5.4.2 Regulatory and Environmental Constraints

The Town's existing permits have not been reviewed since 2013 and are insufficient for the full current and future demand and climate change resilience. The current PTTW limits are as follows:

- ABL system: 46,742,000 L/day
- FMC system: 22,912,000 L/day
- HR system: 45,255,000 L/day
- Total permitted water taking is approximately 115,000,000 L/day
- Consumption Thresholds: Any new or increased consumptive use averaging 19,000 m³/day over a rolling 90-day period triggers a binational review under the Great Lakes–St. Lawrence River Basin Sustainable Water Resources Agreement.

5.4.3 Operational Limitations and Bylaws

Hydraulic modeling confirms that the current "on-demand" operation leads to channel depletion when multiple growers irrigate simultaneously. Two major operational factors restrict the system's effective capacity:

- Noise Bylaw 4588-12: Currently, farmers are often prohibited from operating pumps at night, effectively limiting irrigation to 12 hours per day. Modeling suggests that lifting this restriction during drought periods to allow 24-hour irrigation would effectively double the serviceable capacity without increasing instantaneous flow rates.
- Infrastructure Blockages: The presence of invasive phragmites and sedimentation in municipal drains significantly restricts flow velocities and channel capacity, creating bottlenecks that prevent water from reaching downstream irrigators.

5.4.4 Sizing the infrastructure for the Gross Irrigation Requirements

To achieve the target level of service, the hydraulic design must accommodate minimally the following upgrades:

- Eastchester PS: Increasing capacity.
- Whirlpool PS: Adding a second pump to significantly increase capacity.
- Dee Road PS: Installing a third pump specifically to supplement the FMC system through new interconnections.

The integration of irrigation scheduling and rotation is would also enable significantly higher access to irrigation water. Without a coordinated irrigation cycling, the instantaneous demand required to satisfy all users simultaneously would far exceed both the physical capacity of the channels and the PTTW limits.

6. Next Steps: Integration of Scheduling and Hydraulic Modelling

This memo confirms that achieving the target Level of Service (LOS) and providing the Gross Irrigation Requirements of irrigation water over a peak cycle during 10-year return period drought is the primary driver for the next stage of engineering for NOTL. The preliminary assessment reveals a substantial gap between peak drought demand and the current physical and regulatory capacities of the ABL, FMC, and HR systems. The definitive next step is to integrate high-fidelity hydraulic modelling with water rotation scheduling to ensure system viability. Other next steps include increasing pumping capacity and adding in new delivery channels/culverts/piping that will be further engineered as per the RFP.

6.1 Hydraulic Modelling for Final Sizing

The core objective is to utilize the Region's standard software, InfoWater, to definitively size and validate proposed infrastructure upgrades.

- **Infrastructure Validation:** Modelling will confirm the required capacity for doubling the Eastchester Pumping Station, adding a second pump at Whirlpool PS and upgrading the Dee Road PS for inter-system transfers.
- **Bottleneck Identification:** The model must simulate flow across all municipal drains and channels to identify where culvert upsizing or channel re-construction is required to meet the target LOS.
- **Conveyance Efficiency:** Final sizing must account for open-channel losses, aiming to maintain at least 70% efficiency during peak periods.

6.2 Integration of Operational Scheduling

Volumetric calculations confirm that meeting the target of 4.9, 6.5, 10, 21.1 and 7.8 mm per day for respectively vineyard, orchard, greenhouse, nursery and golf course in a peak demand period, through a purely "on-demand" system is impossible under physical and regulatory constraints.

- **PTTW Compliance:** Operational strategies must ensure the total taking remains below the current PTTW limits, unless permitted maximums can be increased.
- **Mandatory Rotation (Irrigation cycling):** A coordinated rotation scheme must be integrated into the hydraulic model. This involves operating control structures for specific periods to supply individual branches, after which irrigators must shut off on-farm pumps to allow flow to reach downstream users.
- **Optimization:** Comparing different cycling scenarios (e.g., 2-day or 3-day rotations) will minimize capital costs for culverts and hydraulic infrastructures while ensuring equitable distribution.

6.3 Final Reliability and Pressure Guarantee

The concluding step is to ensure that physical upgrades and scheduling protocols meet the specialized needs of NOTL growers.

- **System Interconnection:** Modelling must validate the requirements to interconnect the HR, FMC, and ABL systems to provide security of supply in the event of local pump failures.
- **Reporting:** All findings will culminate in a formal Hydraulic Modelling Report, which will serve as the technical foundation for the Consolidated Engineering Report and final tender documents.

Appendix A. CROPWAT Model Input and Results

Crop Water Requirements

Grape, 10-year drought period, max Kc = 0.8

Month	Decade	Stage	Kc	ETc	ETc	Eff rain	Irr. Req.
			coeff	mm/day	mm/dec	mm/dec	mm/dec
Oct	2	Init	0.46	0.79	6.3	10.5	1.6
Oct	3	Init	0.30	0.47	5.1	11.5	0.0
Nov	1	Init	0.30	0.42	4.2	9.0	0.0
Nov	2	Init	0.30	0.36	3.6	7.3	0.0
Nov	3	Init	0.30	0.32	3.2	9.0	0.0
Dec	1	Init	0.30	0.28	2.8	11.7	0.0
Dec	2	Init	0.30	0.24	2.4	13.3	0.0
Dec	3	Init	0.30	0.23	2.6	12.2	0.0
Jan	1	Init	0.30	0.22	2.2	10.5	0.0
Jan	2	Init	0.30	0.22	2.2	9.6	0.0
Jan	3	Init	0.30	0.23	2.5	9.8	0.0
Feb	1	Init	0.30	0.24	2.4	10.3	0.0
Feb	2	Init	0.30	0.25	2.5	10.5	0.0
Feb	3	Init	0.30	0.30	2.4	9.6	0.0
Mar	1	Init	0.30	0.35	3.5	8.0	0.0
Mar	2	Deve	0.35	0.46	4.6	6.9	0.0
Mar	3	Deve	0.45	0.71	7.8	8.7	0.0
Apr	1	Deve	0.56	1.02	10.2	11.8	0.0
Apr	2	Deve	0.66	1.37	13.7	13.7	0.0
Apr	3	Deve	0.76	1.81	18.1	11.7	6.4
May	1	Mid	0.80	2.17	21.7	8.6	13.0
May	2	Mid	0.80	2.42	24.2	6.8	17.4
May	3	Mid	0.80	2.68	29.5	7.7	21.8
Jun	1	Mid	0.80	2.95	29.5	9.0	20.5
Jun	2	Mid	0.80	3.22	32.2	9.6	22.6
Jun	3	Mid	0.80	3.33	33.3	9.8	23.5
Jul	1	Mid	0.80	3.49	34.9	9.8	25.0
Jul	2	Mid	0.80	3.62	36.2	10.0	26.2
Jul	3	Mid	0.80	3.42	37.6	10.4	27.2
Aug	1	Mid	0.80	3.18	31.8	11.1	20.7
Aug	2	Mid	0.80	3.01	30.1	11.6	18.4
Aug	3	Mid	0.80	2.72	30.0	10.7	19.2
Sep	1	Late	0.77	2.35	23.5	9.3	14.2
Sep	2	Late	0.68	1.84	18.4	8.3	10.1
Sep	3	Late	0.60	1.42	14.2	9.6	4.6
Oct	1	Late	0.51	1.05	10.5	11.7	0.0
Oct	2	Late	0.46	0.79	1.6	2.6	1.6
					541.4	362.2	294.2

Data

Monthly rain - D:\Program Files\CLIMWAT\Niagara.crm

Station Eff. rain method **USDA S.C. Method**

	Rain	Eff rain
	mm	mm
January	31.4	29.8
February	32.1	30.5
March	24.4	23.4
April	39.9	37.4
May	23.9	23.0
June	30.0	28.6
July	31.8	30.2
August	35.5	33.5
September	28.3	27.0
October	38.9	36.5
November	26.3	25.2
December	39.7	37.2
Total	382.2	362.2

Monthly ETo Penman-Monteith - D:\Program Files\CLIMWAT\Niagara-.pem

Country Station

Altitude m. Latitude °N Longitude °W

Month	Min Temp	Max Temp	Humidity	Wind	Sun	Rad	ETo
	°C	°C	%	km/day	hours	MJ/m²/day	mm/day
January	-6.8	0.2	78	389	2.9	5.4	0.72
February	-6.4	0.8	77	379	3.9	8.1	0.85
March	-2.6	5.3	76	350	5.3	12.4	1.32
April	2.4	11.6	78	326	6.8	17.1	2.09
May	8.0	18.6	82	259	8.3	21.1	3.01
June	14.0	24.1	82	252	9.6	23.7	4.02
July	17.2	27.1	83	245	9.9	23.6	4.42
August	16.6	26.1	85	242	8.6	20.1	3.75
September	12.9	22.3	85	259	6.9	15.1	2.70
October	7.1	15.5	82	310	5.1	10.0	1.73
November	1.5	8.9	77	341	2.8	5.7	1.22
December	-3.0	3.2	79	365	2.2	4.4	0.80
Average	5.1	13.6	80	310	6.0	13.9	2.22

Dry crop - C:\ProgramData\CROPWAT\data\crops\FAO\GRAPES-W.CRO

Crop Name Planting date Harvest

	initial	development	mid-season	late season	total
Kc Values	0.30		0.80		0.45
Stage (days)	150	50	125	40	365
Rooting depth (m)	0.90		0.90		
Critical depletion (fraction)	0.45		0.45	0.45	
Yield response f.	0.20	0.70	0.85	0.40	0.85
Cropheight (m)			1.80 (optional)		

Soil - C:\ProgramData\CROPWAT\data\soils\FAO\MEDIUM.SOI

Soil name

General soil data

Total available soil moisture (FC - WP)	290.0	mm/meter
Maximum rain infiltration rate	40	mm/day
Maximum rooting depth	90	centimeters
Initial soil moisture depletion (as % TAM)	40	%
Initial available soil moisture	174.0	mm/meter

Orchard, 10-year drought period, max Kc = 1.00

Month	Decade	Stage	Kc	ETc	ETc	Eff rain	Irr. Req.
			coeff	mm/day	mm/dec	mm/dec	mm/dec
Oct	2	Init	0.46	0.80	6.4	10.5	1.6
Oct	3	Init	0.30	0.47	5.1	11.5	0.0
Nov	1	Init	0.30	0.42	4.2	9.0	0.0
Nov	2	Init	0.30	0.36	3.6	7.3	0.0
Nov	3	Init	0.30	0.32	3.2	9.0	0.0
Dec	1	Init	0.30	0.28	2.8	11.7	0.0
Dec	2	Init	0.30	0.24	2.4	13.3	0.0
Dec	3	Init	0.30	0.23	2.6	12.2	0.0
Jan	1	Init	0.30	0.22	2.2	10.5	0.0
Jan	2	Init	0.30	0.22	2.2	9.6	0.0
Jan	3	Init	0.30	0.23	2.5	9.8	0.0
Feb	1	Init	0.30	0.24	2.4	10.3	0.0
Feb	2	Init	0.30	0.25	2.5	10.5	0.0
Feb	3	Init	0.30	0.30	2.4	9.6	0.0
Mar	1	Init	0.30	0.35	3.5	8.0	0.0
Mar	2	Deve	0.36	0.48	4.8	6.9	0.0
Mar	3	Deve	0.51	0.80	8.8	8.7	0.1
Apr	1	Deve	0.66	1.20	12.0	11.8	0.3
Apr	2	Deve	0.80	1.66	16.6	13.7	2.9
Apr	3	Deve	0.94	2.25	22.5	11.7	10.8
May	1	Mid	1.00	2.71	27.1	8.6	18.4
May	2	Mid	1.00	3.02	30.2	6.8	23.4
May	3	Mid	1.00	3.35	36.9	7.7	29.2
Jun	1	Mid	1.00	3.69	36.9	9.0	27.9
Jun	2	Mid	1.00	4.02	40.2	9.6	30.6
Jun	3	Mid	1.00	4.16	41.6	9.8	31.8
Jul	1	Mid	1.00	4.36	43.6	9.8	33.7
Jul	2	Mid	1.00	4.53	45.3	10.0	35.2
Jul	3	Mid	1.00	4.27	47.0	10.4	36.6
Aug	1	Mid	1.00	3.98	39.8	11.1	28.7
Aug	2	Mid	1.00	3.76	37.6	11.6	25.9
Aug	3	Mid	1.00	3.40	37.4	10.7	26.7
Sep	1	Late	0.95	2.90	29.0	9.3	19.8
Sep	2	Late	0.82	2.20	22.0	8.3	13.7
Sep	3	Late	0.68	1.61	16.1	9.6	6.5
Oct	1	Late	0.54	1.11	11.1	11.7	0.0
Oct	2	Late	0.46	0.80	1.6	2.6	1.6
					656.2	362.2	405.5

Data

Monthly rain - D:\Program Files\CLIMWAT\Niagara.crm

Station Eff. rain method **USDA S.C. Method**

	Rain	Eff rain
	mm	mm
January	31.4	29.8
February	32.1	30.5
March	24.4	23.4
April	39.9	37.4
May	23.9	23.0
June	30.0	28.6
July	31.8	30.2
August	35.5	33.5
September	28.3	27.0
October	38.9	36.5
November	26.3	25.2
December	39.7	37.2
Total	382.2	362.2

Monthly ETo Penman-Monteith - D:\Program Files\CLIMWAT\Niagara-.pem

Country Station

Altitude m. Latitude °N Longitude °W

Month	Min Temp	Max Temp	Humidity	Wind	Sun	Rad	ETo
	°C	°C	%	km/day	hours	MJ/m²/day	mm/day
January	-6.8	0.2	78	389	2.9	5.4	0.72
February	-6.4	0.8	77	379	3.9	8.1	0.85
March	-2.6	5.3	76	350	5.3	12.4	1.32
April	2.4	11.6	78	326	6.8	17.1	2.09
May	8.0	18.6	82	259	8.3	21.1	3.01
June	14.0	24.1	82	252	9.6	23.7	4.02
July	17.2	27.1	83	245	9.9	23.6	4.42
August	16.6	26.1	85	242	8.6	20.1	3.75
September	12.9	22.3	85	259	6.9	15.1	2.70
October	7.1	15.5	82	310	5.1	10.0	1.73
November	1.5	8.9	77	341	2.8	5.7	1.22
December	-3.0	3.2	79	365	2.2	4.4	0.80
Average	5.1	13.6	80	310	6.0	13.9	2.22

Dry crop - C:\ProgramData\CROPWAT\data\crops\FAO\GRAPES-W.CRO

Crop Name Planting date Harvest

	initial	development	mid-season	late season	total
Kc Values	0.30		1.00	0.45	
Stage (days)	150	50	125	40	365
Rooting depth (m)	0.90		1.00		
Critical depletion (fraction)	0.45		0.45	0.45	
Yield response f.	0.20	0.70	0.85	0.40	0.85
Cropheight (m)			1.80 (optional)		

Soil - C:\ProgramData\CROPWAT\data\soils\FAO\MEDIUM.SOI

Soil name

General soil data

Total available soil moisture (FC - WP)	290.0	mm/meter
Maximum rain infiltration rate	40	mm/day
Maximum rooting depth	100	centimeters
Initial soil moisture depletion (as % TAM)	40	%
Initial available soil moisture	174.0	mm/meter

Vineyard, 5-year drought period, max Kc = 0.8

Month	Decade	Stage	Kc	ETc	ETc	Eff rain	Irr. Req.
			coeff	mm/day	mm/dec	mm/dec	mm/dec
Oct	2	Init	0.46	0.79	6.3	12.9	1.6
Oct	3	Init	0.30	0.47	5.1	14.4	0.0
Nov	1	Init	0.30	0.42	4.2	11.6	0.0
Nov	2	Init	0.30	0.36	3.6	9.8	0.0
Nov	3	Init	0.30	0.32	3.2	11.3	0.0
Dec	1	Init	0.30	0.28	2.8	13.7	0.0
Dec	2	Init	0.30	0.24	2.4	15.1	0.0
Dec	3	Init	0.30	0.23	2.6	14.1	0.0
Jan	1	Init	0.30	0.22	2.2	12.6	0.0
Jan	2	Init	0.30	0.22	2.2	11.7	0.0
Jan	3	Init	0.30	0.23	2.5	11.9	0.0
Feb	1	Init	0.30	0.24	2.4	12.4	0.0
Feb	2	Init	0.30	0.25	2.5	12.6	0.0
Feb	3	Init	0.30	0.30	2.4	12.1	0.0
Mar	1	Init	0.30	0.35	3.5	10.8	0.0
Mar	2	Deve	0.35	0.46	4.6	10.1	0.0
Mar	3	Deve	0.45	0.71	7.8	11.8	0.0
Apr	1	Deve	0.56	1.02	10.2	14.6	0.0
Apr	2	Deve	0.66	1.37	13.7	16.5	0.0
Apr	3	Deve	0.76	1.81	18.1	14.4	3.7
May	1	Mid	0.80	2.17	21.7	11.2	10.5
May	2	Mid	0.80	2.42	24.2	9.1	15.0
May	3	Mid	0.80	2.68	29.5	10.3	19.2
Jun	1	Mid	0.80	2.95	29.5	12.1	17.4
Jun	2	Mid	0.80	3.22	32.2	13.0	19.2
Jun	3	Mid	0.80	3.33	33.3	13.0	20.2
Jul	1	Mid	0.80	3.49	34.9	12.9	22.0
Jul	2	Mid	0.80	3.62	36.2	13.0	23.2
Jul	3	Mid	0.80	3.42	37.6	13.4	24.2
Aug	1	Mid	0.80	3.18	31.8	14.1	17.8
Aug	2	Mid	0.80	3.01	30.1	14.6	15.5
Aug	3	Mid	0.80	2.72	30.0	13.5	16.5
Sep	1	Late	0.77	2.35	23.5	11.6	11.9
Sep	2	Late	0.68	1.84	18.4	10.3	8.1
Sep	3	Late	0.60	1.42	14.2	11.9	2.3
Oct	1	Late	0.51	1.05	10.5	14.5	0.0
Oct	2	Late	0.46	0.79	1.6	3.2	1.6
					541.4	456.3	249.8

Data

Monthly rain - D:\Program Files\CLIMWAT\Niagara.crm

Station Eff. rain method

	Rain	Eff rain
	mm	mm
January	38.5	36.1
February	39.7	37.2
March	34.5	32.6
April	49.5	45.6
May	32.2	30.5
June	40.9	38.2
July	42.0	39.2
August	45.6	42.3
September	35.7	33.7
October	49.1	45.2
November	34.5	32.6
December	46.4	43.0
Total	488.6	456.2

Monthly ETo Penman-Monteith - D:\Program Files\CLIMWAT\Niagara-.pem

Country Station

Altitude m. Latitude °N Longitude °W

Month	Min Temp	Max Temp	Humidity	Wind	Sun	Rad	ETo
	°C	°C	%	km/day	hours	MJ/m²/day	mm/day
January	-6.8	0.2	78	389	2.9	5.4	0.72
February	-6.4	0.8	77	379	3.9	8.1	0.85
March	-2.6	5.3	76	350	5.3	12.4	1.32
April	2.4	11.6	78	326	6.8	17.1	2.09
May	8.0	18.6	82	259	8.3	21.1	3.01
June	14.0	24.1	82	252	9.6	23.7	4.02
July	17.2	27.1	83	245	9.9	23.6	4.42
August	16.6	26.1	85	242	8.6	20.1	3.75
September	12.9	22.3	85	259	6.9	15.1	2.70
October	7.1	15.5	82	310	5.1	10.0	1.73
November	1.5	8.9	77	341	2.8	5.7	1.22
December	-3.0	3.2	79	365	2.2	4.4	0.80
Average	5.1	13.6	80	310	6.0	13.9	2.22

Dry crop - C:\ProgramData\CROPWAT\data\crops\FAO\GRAPES-W.CRO

Crop Name Planting date Harvest

	initial	development	mid-season	late season	total
Kc Values	0.30		0.80		0.45
Stage (days)	150	50	125	40	365
Rooting depth (m)	0.90		0.90		
Critical depletion (fraction)	0.45		0.45	0.45	
Yield response f.	0.20	0.70	0.85	0.40	0.85
Cropheight (m)			1.80 (optional)		

Soil - C:\ProgramData\CROPWAT\data\soils\FAO\MEDIUM.SOI

Soil name

General soil data

Total available soil moisture (FC - WP)	290.0	mm/meter
Maximum rain infiltration rate	40	mm/day
Maximum rooting depth	90	centimeters
Initial soil moisture depletion (as % TAM)	40	%
Initial available soil moisture	174.0	mm/meter

Orchard, 5-year drought period, max Kc = 1.00

Month	Decade	Stage	Kc	ETc	ETc	Eff rain	Irr. Req.
			coeff	mm/day	mm/dec	mm/dec	mm/dec
Oct	2	Init	0.46	0.80	6.4	12.9	1.6
Oct	3	Init	0.30	0.47	5.1	14.4	0.0
Nov	1	Init	0.30	0.42	4.2	11.6	0.0
Nov	2	Init	0.30	0.36	3.6	9.8	0.0
Nov	3	Init	0.30	0.32	3.2	11.3	0.0
Dec	1	Init	0.30	0.28	2.8	13.7	0.0
Dec	2	Init	0.30	0.24	2.4	15.1	0.0
Dec	3	Init	0.30	0.23	2.6	14.1	0.0
Jan	1	Init	0.30	0.22	2.2	12.6	0.0
Jan	2	Init	0.30	0.22	2.2	11.7	0.0
Jan	3	Init	0.30	0.23	2.5	11.9	0.0
Feb	1	Init	0.30	0.24	2.4	12.4	0.0
Feb	2	Init	0.30	0.25	2.5	12.6	0.0
Feb	3	Init	0.30	0.30	2.4	12.1	0.0
Mar	1	Init	0.30	0.35	3.5	10.8	0.0
Mar	2	Deve	0.36	0.48	4.8	10.1	0.0
Mar	3	Deve	0.51	0.80	8.8	11.8	0.0
Apr	1	Deve	0.66	1.20	12.0	14.6	0.0
Apr	2	Deve	0.80	1.66	16.6	16.5	0.1
Apr	3	Deve	0.94	2.25	22.5	14.4	8.1
May	1	Mid	1.00	2.71	27.1	11.2	15.9
May	2	Mid	1.00	3.02	30.2	9.1	21.0
May	3	Mid	1.00	3.35	36.9	10.3	26.6
Jun	1	Mid	1.00	3.69	36.9	12.1	24.8
Jun	2	Mid	1.00	4.02	40.2	13.0	27.2
Jun	3	Mid	1.00	4.16	41.6	13.0	28.5
Jul	1	Mid	1.00	4.36	43.6	12.9	30.7
Jul	2	Mid	1.00	4.53	45.3	13.0	32.2
Jul	3	Mid	1.00	4.27	47.0	13.4	33.6
Aug	1	Mid	1.00	3.98	39.8	14.1	25.7
Aug	2	Mid	1.00	3.76	37.6	14.6	23.0
Aug	3	Mid	1.00	3.40	37.4	13.5	24.0
Sep	1	Late	0.95	2.90	29.0	11.6	17.4
Sep	2	Late	0.82	2.20	22.0	10.3	11.7
Sep	3	Late	0.68	1.61	16.1	11.9	4.2
Oct	1	Late	0.54	1.11	11.1	14.5	0.0
Oct	2	Late	0.46	0.80	1.6	3.2	1.6
					656.2	456.3	357.9

Data:

Monthly rain - D:\Program Files\CLIMWAT\Niagara.crm

Station Eff. rain method

	Rain	Eff rain
	mm	mm
January	38.5	36.1
February	39.7	37.2
March	34.5	32.6
April	49.5	45.6
May	32.2	30.5
June	40.9	38.2
July	42.0	39.2
August	45.6	42.3
September	35.7	33.7
October	49.1	45.2
November	34.5	32.6
December	46.4	43.0
Total	488.6	456.2

Monthly ETo Penman-Monteith - D:\Program Files\CLIMWAT\Niagara-.pem

Country Station

Altitude m. Latitude °N Longitude °W

Month	Min Temp	Max Temp	Humidity	Wind	Sun	Rad	ETo
	°C	°C	%	km/day	hours	MJ/m ² /day	mm/day
January	-6.8	0.2	78	389	2.9	5.4	0.72
February	-6.4	0.8	77	379	3.9	8.1	0.85
March	-2.6	5.3	76	350	5.3	12.4	1.32
April	2.4	11.6	78	326	6.8	17.1	2.09
May	8.0	18.6	82	259	8.3	21.1	3.01
June	14.0	24.1	82	252	9.6	23.7	4.02
July	17.2	27.1	83	245	9.9	23.6	4.42
August	16.6	26.1	85	242	8.6	20.1	3.75
September	12.9	22.3	85	259	6.9	15.1	2.70
October	7.1	15.5	82	310	5.1	10.0	1.73
November	1.5	8.9	77	341	2.8	5.7	1.22
December	-3.0	3.2	79	365	2.2	4.4	0.80
Average	5.1	13.6	80	310	6.0	13.9	2.22

Dry crop - C:\ProgramData\CROPWAT\data\crops\FAO\GRAPES-W.CRO

Crop Name Planting date Harvest

	initial	development	mid-season	late season	total
Kc Values	0.30		1.00		0.45
Stage (days)	150	50	125	40	365
Rooting depth (m)	0.90		1.00		
Critical depletion (fraction)	0.45		0.45	0.45	
Yield response f.	0.20	0.70	0.85	0.40	0.85
Cropheight (m)			1.80 (optional)		

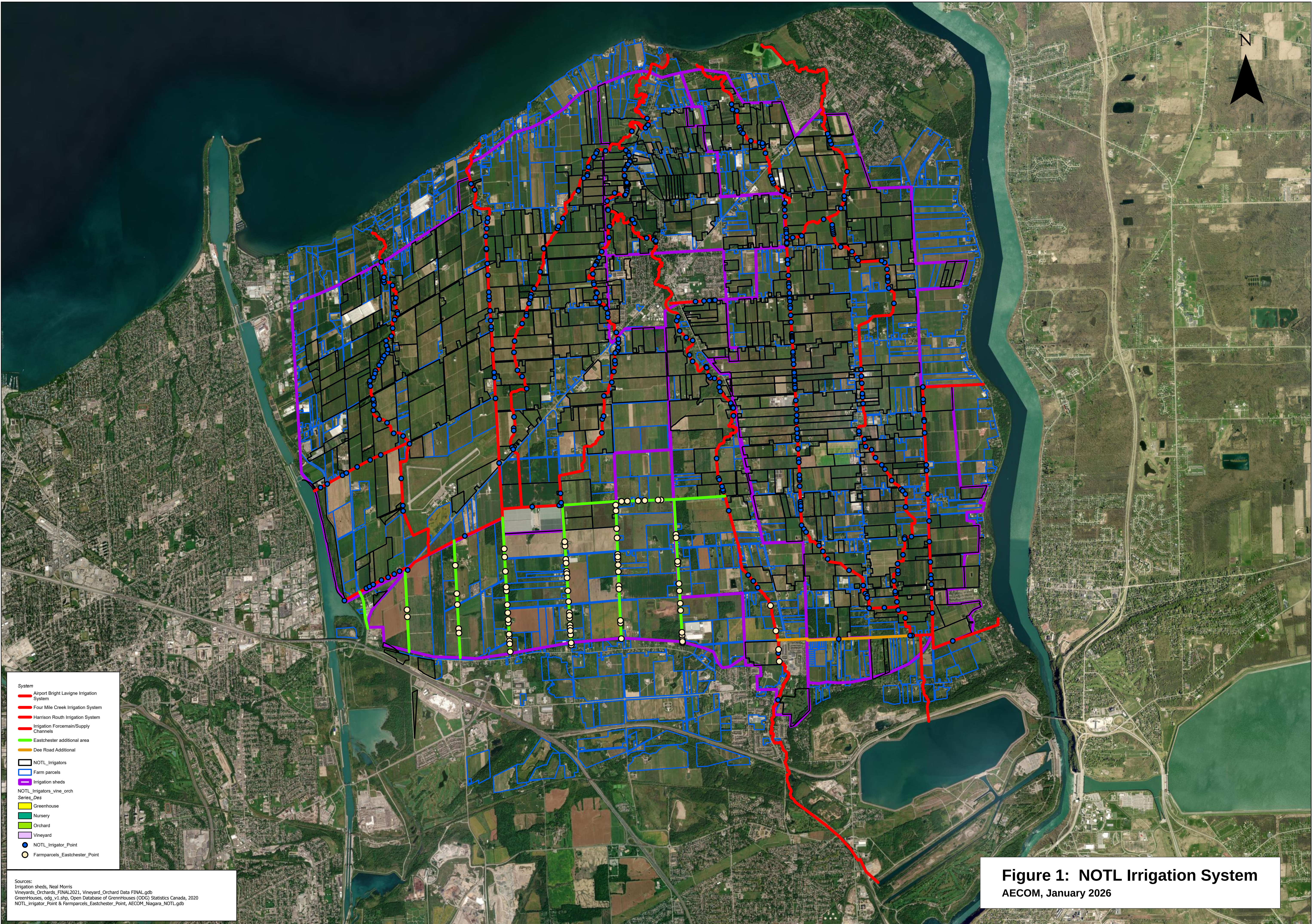
Soil - C:\ProgramData\CROPWAT\data\soils\FAO\MEDIUM.SOI

Soil name

General soil data

Total available soil moisture (FC - WP)	290.0	mm/meter
Maximum rain infiltration rate	40	mm/day
Maximum rooting depth	100	centimeters
Initial soil moisture depletion (as % TAM)	40	%
Initial available soil moisture	174.0	mm/meter

Appendix B. GIS Analysis Figures



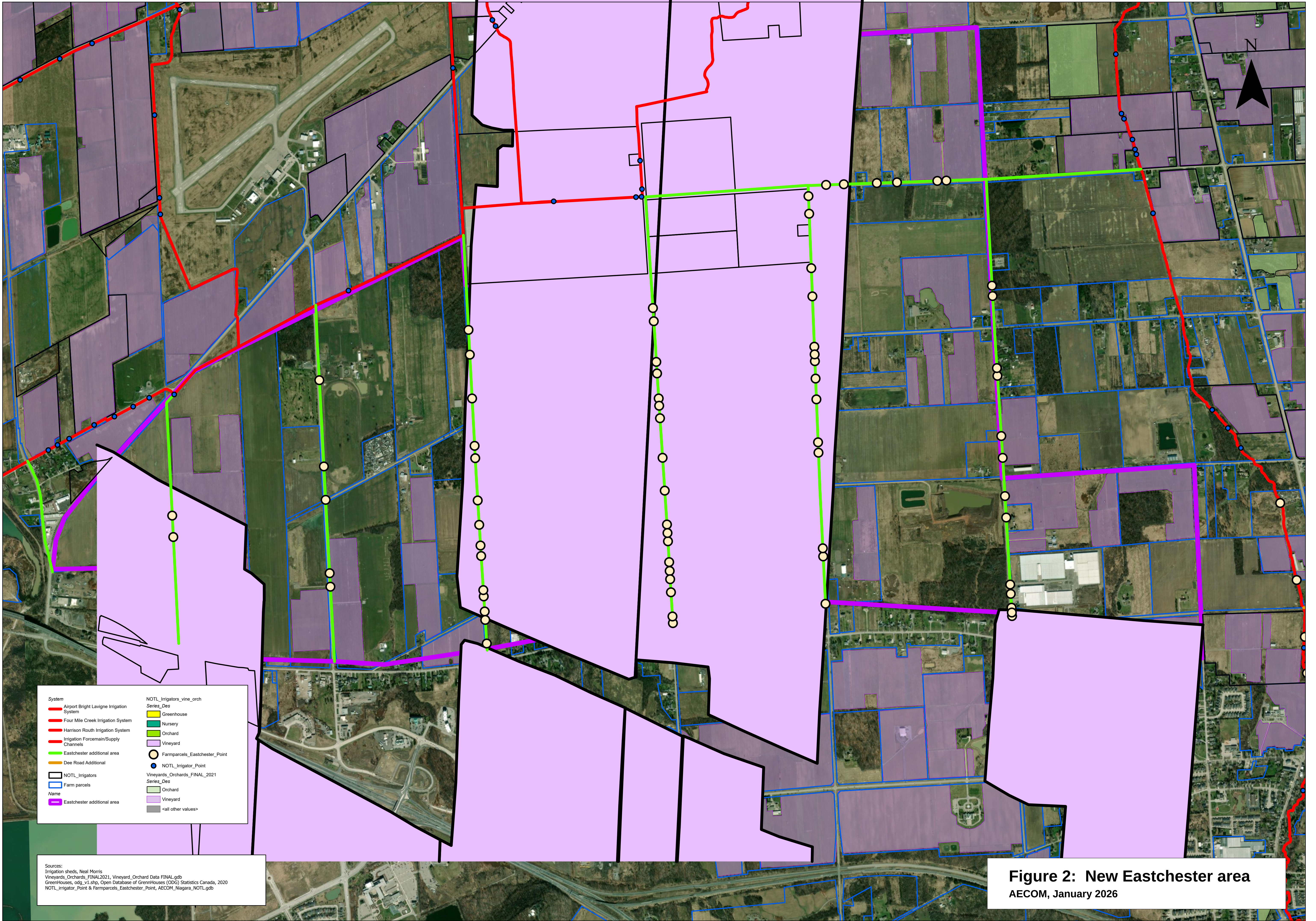


Figure 2: New Eastchester area
AECOM, January 2026

Appendix C. Volumetric Results

ID	DESCRIPTION	Year Irrigator	Uniq. Ident.	Parcel Area (m ²)	Crop Areas				Peak Gross Water Volume Requirement per day				
					Vineyard (m ²)	Orchard (m ²)	Nursery (m ²)	Greenhouse (m ²)	Vineyard (m ³)	Orchard (m ³)	Nursery (m ³)	Greenhouse (m ³)	Total (m ³)
1	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	1	24 963,75	8 732,95	0,00	0,00	0,00	42,79	0,00	0,00	0,00	42,79
2	Vacant residential/commercial/ industrial land owned by a non-farmer with a portion being farmed	2025 Irrigators	2	84 469,22	64 063,25	0,00	0,00	0,00	313,91	0,00	0,00	0,00	313,91
3	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	3	133 423,33	115 602,51	0,00	0,00	0,00	566,45	0,00	0,00	0,00	566,45
4	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	4	419 730,51	369 072,83	4 168,55	0,00	0,00	1 808,46	27,10	0,00	0,00	1 835,55
5	Vacant residential/commercial/ industrial land owned by a non-farmer with a portion being farmed	2025 Irrigators	5	94 013,31	75 876,02	0,00	0,00	0,00	371,79	0,00	0,00	0,00	371,79
6	Farm with residence - with or without secondary structures; with farm outbuildings	2021 Irrigators	6	180 991,35	37 650,79	83 636,74	0,00	0,00	184,49	543,64	0,00	0,00	728,13
7	Farm without residence - with secondary structures; with farm outbuildings	2021 Irrigators	7	42 963,36	13 347,18	16,00	0,00	0,00	65,40	0,10	0,00	0,00	65,51
8	Farm property without any buildings/structures	2021 Irrigators	8	51 459,98	33 502,72	13 150,17	0,00	0,00	164,16	85,48	0,00	0,00	249,64
9	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	9	91 969,94	82 842,42	0,11	0,00	0,00	405,93	0,00	0,00	0,00	405,93
10	Farm property without any buildings/structures	2025 Irrigators	10	67 880,97	62 642,60	0,00	0,00	0,00	306,95	0,00	0,00	0,00	306,95
11	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	11	90 036,78	78 493,98	114,29	0,00	0,00	384,62	0,74	0,00	0,00	385,36
12	Farm property without any buildings/structures	2021 Irrigators	12	116 694,54	57 391,54	37 127,72	0,00	0,00	281,22	241,33	0,00	0,00	522,55
13	Farm with a winery	2021 Irrigators	13	198 196,94	165 346,98	4 575,71	0,00	0,00	810,20	29,74	0,00	0,00	839,94
14	Farm with residence - with or without secondary structures; with farm outbuildings	2021 Irrigators	14	95 513,45	85 136,96	64,49	0,00	0,00	417,17	0,42	0,00	0,00	417,59
15	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	15	40 544,53	2,13	36 348,30	0,00	0,00	0,01	236,26	0,00	0,00	236,27
16	Farm property without any buildings/structures	2025 Irrigators	16	13 792,28	0,00	506,60	0,00	0,00	0,00	3,29	0,00	0,00	3,29
17	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	17	56 326,80	0,00	49 655,64	0,00	0,00	0,00	322,76	0,00	0,00	322,76
18	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	18	12 135,67	68,81	9 549,98	0,00	0,00	0,34	62,07	0,00	0,00	62,41
19	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	19	27 884,39	0,00	23 670,39	0,00	0,00	0,00	153,86	0,00	0,00	153,86
20	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	20	174 362,89	97 704,66	67 075,56	0,00	0,00	478,75	435,99	0,00	0,00	914,74
21	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2024 Irrigators	21	30 980,59	26 737,97	418,84	0,00	0,00	131,02	2,72	0,00	0,00	133,74
22	Farm without residence - with secondary structures; with farm outbuildings	2021 Irrigators	22	60 847,34	54 217,84	313,44	0,00	0,00	265,67	2,04	0,00	0,00	267,70
23	Farm property without any buildings/structures	2024 Irrigators	23	35 654,53	30 496,17	0,00	0,00	0,00	149,43	0,00	0,00	0,00	149,43
24	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	24	53 207,94	50 569,48	9,54	0,00	0,00	247,79	0,06	0,00	0,00	247,85
25	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	25	36 241,18	350,71	32 537,69	0,00	0,00	1,72	211,50	0,00	0,00	213,21
26	Farm property without any buildings/structures	2025 Irrigators	26	123 191,75	85,86	119 931,19	0,00	0,00	0,42	779,55	0,00	0,00	779,97
27	Single family detached (not on water)	2025 Irrigators	27	5 222,11	0,00	1 863,63	0,00	0,00	0,00	12,11	0,00	0,00	12,11
28	Farm with residence - with or without secondary structures; no farm outbuildings	2025 Irrigators	28	20 308,01	0,00	17 417,64	0,00	0,00	0,00	113,21	0,00	0,00	113,21
29	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	29	18 795,67	0,00	16 983,74	0,00	0,00	0,00	110,39	0,00	0,00	110,39
30	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	30	21 729,27	0,00	18 494,97	0,00	0,00	0,00	120,22	0,00	0,00	120,22
31	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	31	20 205,09	16 348,06	709,97	0,00	0,00	80,11	4,61	0,00	0,00	84,72
32	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	32	20 213,04	30,52	15 687,29	0,00	0,00	0,15	101,97	0,00	0,00	102,12
33	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	33	20 211,96	49,23	15 858,99	0,00	0,00	0,24	103,08	0,00	0,00	103,32
34	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	34	43 122,32	93,45	39 233,28	0,00	0,00	0,46	255,02	0,00	0,00	255,47
35	Land owned by a farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	35	38 961,21	0,00	30 612,46	0,00	0,00	0,00	198,98	0,00	0,00	198,98
36	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	36	34 838,52	0,00	25 838,68	0,00	0,00	0,00	167,95	0,00	0,00	167,95
37	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	37	47 399,58	39 611,13	0,00	0,00	0,00	194,09	0,00	0,00	0,00	194,09
38	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	38	47 434,70	40 509,96	37,86	0,00	0,00	198,50	0,25	0,00	0,00	198,74
39	Farm with residence - with or without secondary structures; with farm outbuildings	2023 Irrigators	39	63 112,99	53 611,53	5,94	0,00	0,00	262,70	0,04	0,00	0,00	262,74
40	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	40	226 555,76	16 320,74	153 793,17	0,00	0,00	79,97	999,66	0,00	0,00	1 079,63
41	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	41	52 626,68	45 694,92	0,00	0,00	0,00	223,91	0,00	0,00	0,00	223,91
42	Farm property without any buildings/structures	2025 Irrigators	42	55 413,57	50 182,08	0,00	0,00	0,00	245,89	0,00	0,00	0,00	245,89
43	Farm property without any buildings/structures	2025 Irrigators	43	28 113,35	22 598,94	0,00	0,00	0,00	110,73	0,00	0,00	0,00	110,73
44	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	44	48 031,25	0,00	30 817,90	0,00	0,00	0,00	200,32	0,00	0,00	200,32
45	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	45	118 004,74	0,00	83 888,58	0,00	0,00	0,00	545,28	0,00	0,00	545,28
46	Single family detached (not on water)	2025 Irrigators	46	2 332,38	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
47	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2023 Irrigators	47	15 952,18	0,00	9 783,59	0,00	0,00	0,00	63,59	0,00	0,00	63,59
48	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2021 Irrigators	48	19 217,52	0,00	16 020,28	0,00	0,00	0,00	104,13	0,00	0,00	104,13
49	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	49	34 359,26	0,00	23 794,53	0,00	0,00	0,00	154,66	0,00	0,00	154,66
50	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	50	24 930,41	15 988,04	383,11	0,00	0,00	78,34	2,49	0,00	0,00	80,83
51	Farm property without any buildings/structures	2025 Irrigators	51	43 581,30	42 401,80	0,00	0,00	0,00	207,77	0,00	0,00	0,00	207,77
52	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	52	49 167,31	43 754,26	0,00	0,00	0,00	214,40	0,00	0,00	0,00	214,40
53	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	53	92 738,36	72 502,86	0,00	0,00	0,00	355,26	0,00	0,00	0,00	355,26
54	Farm with residence - with or without secondary structures; no farm outbuildings	2025 Irrigators	54	21 567,02	18 661,21	0,00	0,00	0,00	91,44	0,00	0,00	0,00	91,44
55	Single family detached (not on water)	2025 Irrigators	55	5 103,59	50,97	0,00	0,00	0,00	0,25	0,00	0,00	0,00	0,25
56	Farm property without any buildings/structures	2025 Irrigators	56	41 949,39	41 529,19	0,00	0,00	0,00	203,49	0,00	0,00	0,00	203,49

ID	DESCRIPTION	Year Irrigator	Uniq. Ident.	Parcel Area (m ²)	Crop Areas				Peak Gross Water Volume Requirement per day				
					Vineyard (m ²)	Orchard (m ²)	Nursery (m ²)	Greenhouse (m ²)	Vineyard (m ³)	Orchard (m ³)	Nursery (m ³)	Greenhouse (m ³)	Total (m ³)
57	Farm property without any buildings/structures	2025 Irrigators	57	55 581,18	54 722,53	0,00	0,00	0,00	268,14	0,00	0,00	0,00	268,14
58	Farm property without any buildings/structures	2025 Irrigators	58	47 279,65	46 187,66	0,00	0,00	0,00	226,32	0,00	0,00	0,00	226,32
59	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	59	117 353,57	98 396,17	0,00	0,00	0,00	482,14	0,00	0,00	0,00	482,14
60	Farm with residence - with or without secondary structures; with farm outbuildings	2022 Irrigators	60	41 117,45	38 405,30	0,00	0,00	0,00	188,19	0,00	0,00	0,00	188,19
61	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	61	60 607,94	57 531,75	0,00	0,00	0,00	281,91	0,00	0,00	0,00	281,91
62	Farm with a winery	2025 Irrigators	62	139 284,56	120 625,10	734,06	0,00	0,00	591,06	4,77	0,00	0,00	595,83
63	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	63	73 737,12	66 670,01	0,00	0,00	0,00	326,68	0,00	0,00	0,00	326,68
64	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	64	20 573,44	16 722,22	0,00	0,00	0,00	81,94	0,00	0,00	0,00	81,94
65	Farm with residence - with or without secondary structures; no farm outbuildings	2025 Irrigators	65	40 442,67	37 079,45	0,00	0,00	0,00	181,69	0,00	0,00	0,00	181,69
66	Farm property without any buildings/structures	2025 Irrigators	66	123 444,64	118 990,36	327,64	0,00	0,00	583,05	2,13	0,00	0,00	585,18
67	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	67	142 280,96	132 265,23	0,00	0,00	0,00	648,10	0,00	0,00	0,00	648,10
68	Farm property without any buildings/structures	2025 Irrigators	68	98 057,82	74 267,67	0,00	0,00	0,00	363,91	0,00	0,00	0,00	363,91
69	Farm property without any buildings/structures	2025 Irrigators	69	40 769,28	40 553,78	0,00	0,00	0,00	198,71	0,00	0,00	0,00	198,71
70	Farm property without any buildings/structures	2025 Irrigators	70	40 597,86	40 540,92	0,00	0,00	0,00	198,65	0,00	0,00	0,00	198,65
71	Farm property without any buildings/structures	2025 Irrigators	71	52 788,42	47 634,01	2,49	0,00	0,00	233,41	0,02	0,00	0,00	233,42
72	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	72	271 904,30	239 487,66	9 345,89	0,00	0,00	1 173,49	60,75	0,00	0,00	1 234,24
73	Farm property without any buildings/structures	2025 Irrigators	73	68 238,93	65 622,55	0,00	0,00	0,00	321,55	0,00	0,00	0,00	321,55
74	Farm property without any buildings/structures	2025 Irrigators	74	24 306,95	22 244,59	0,00	0,00	0,00	109,00	0,00	0,00	0,00	109,00
75	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	75	45 560,78	41 308,31	0,00	0,00	0,00	202,41	0,00	0,00	0,00	202,41
76	Land owned by a farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	76	54 898,13	44 139,99	0,00	0,00	0,00	216,29	0,00	0,00	0,00	216,29
77	Land owned by a farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	77	91 395,64	642,27	60 631,02	0,00	0,00	3,15	394,10	0,00	0,00	397,25
78	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	78	48 181,71	36 963,41	249,07	0,00	0,00	181,12	1,62	0,00	0,00	182,74
79	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	79	60 676,14	450,93	30 124,51	0,00	0,00	2,21	195,81	0,00	0,00	198,02
80	Farm property without any buildings/structures	2025 Irrigators	80	142 016,09	135 998,96	0,00	0,00	0,00	666,39	0,00	0,00	0,00	666,39
81	Farm property without any buildings/structures	2025 Irrigators	81	399 127,34	360 856,17	0,04	0,00	0,00	1 768,20	0,00	0,00	0,00	1 768,20
82	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	82	20 203,93	13 901,58	0,00	0,00	0,00	68,12	0,00	0,00	0,00	68,12
83	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	83	33 690,67	25 312,79	0,00	0,00	0,00	124,03	0,00	0,00	0,00	124,03
84	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	84	190 933,45	174 392,49	6 679,25	0,00	0,00	854,52	43,42	0,00	0,00	897,94
85	Farm with residence - with or without secondary structures; no farm outbuildings	2025 Irrigators	85	103 946,74	97 967,83	475,06	0,00	0,00	480,04	3,09	0,00	0,00	483,13
86	Farm with residence - with or without secondary structures; no farm outbuildings	2025 Irrigators	86	81 259,80	0,00	73 957,59	0,00	0,00	0,00	480,72	0,00	0,00	480,72
87	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	87	53 695,89	0,00	43 300,25	0,00	0,00	0,00	281,45	0,00	0,00	281,45
88	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	88	49 998,25	45 938,75	0,00	0,00	0,00	225,10	0,00	0,00	0,00	225,10
89	Farm property without any buildings/structures	2025 Irrigators	89	161 449,13	157 453,02	0,00	0,00	0,00	771,52	0,00	0,00	0,00	771,52
90	Farm with a winery	2025 Irrigators	90	105 389,54	79 576,01	0,00	0,00	0,00	389,92	0,00	0,00	0,00	389,92
91	Farm property without any buildings/structures	2025 Irrigators	91	75 188,96	71 758,50	0,00	0,00	0,00	351,62	0,00	0,00	0,00	351,62
92	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	92	36 482,69	233,91	0,00	0,00	0,00	1,15	0,00	0,00	0,00	1,15
93	Farm property without any buildings/structures	2025 Irrigators	93	306 031,22	290 585,34	0,00	0,00	0,00	1 423,87	0,00	0,00	0,00	1 423,87
94	Farm property without any buildings/structures	2025 Irrigators	94	102 989,07	101 835,17	0,00	0,00	0,00	498,99	0,00	0,00	0,00	498,99
95	Single family detached (not on water)	2025 Irrigators	95	3 715,68	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
96	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	96	289 348,05	264 612,31	0,00	0,00	0,00	1 296,60	0,00	0,00	0,00	1 296,60
97	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	97	51 596,16	47 552,37	0,00	0,00	0,00	233,01	0,00	0,00	0,00	233,01
98	Farm property without any buildings/structures	2025 Irrigators	98	86 006,81	76 447,08	0,00	0,00	0,00	374,59	0,00	0,00	0,00	374,59
99	Farm without residence - with secondary structures; with farm outbuildings	2021 Irrigators	99	20 825,75	83,71	0,00	0,00	0,00	0,41	0,00	0,00	0,00	0,41
100	Single family detached (not on water)	2021 Irrigators	100	4 047,52	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
101	Farm property without any buildings/structures	2021 Irrigators	101	66 933,68	58 691,47	0,00	0,00	0,00	287,59	0,00	0,00	0,00	287,59
102	Single family detached (not on water)	2021 Irrigators	102	4 065,61	1 826,27	0,00	0,00	0,00	8,95	0,00	0,00	0,00	8,95
103	Single family detached (not on water)	2021 Irrigators	103	4 058,75	1 561,08	0,00	0,00	0,00	7,65	0,00	0,00	0,00	7,65
104	Farm property without any buildings/structures	2025 Irrigators	104	56 487,69	55 569,72	2,45	0,00	0,00	272,29	0,02	0,00	0,00	272,31
105	Large scale poultry operation	2025 Irrigators	105	52 464,73	36,68	39 527,20	0,00	0,00	0,18	256,93	0,00	0,00	257,11
106	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	106	51 784,38	37 962,34	611,36	0,00	0,00	186,02	3,97	0,00	0,00	189,99
107	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	107	17 452,69	14 483,47	0,00	0,00	0,00	70,97	0,00	0,00	0,00	70,97
108	Farm property without any buildings/structures	2025 Irrigators	108	63 604,32	61 173,61	0,00	0,00	0,00	299,75	0,00	0,00	0,00	299,75
109	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	109	4 045,89	13,89	0,00	0,00	0,00	0,07	0,00	0,00	0,00	0,07
110	Farm property without any buildings/structures	2025 Irrigators	110	57 023,73	52 924,69	0,00	0,00	0,00	259,33	0,00	0,00	0,00	259,33
111	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	111	38 716,13	24 460,26	0,00	0,00	0,00	119,86	0,00	0,00	0,00	119,86
112	Farm with residence - with or without secondary structures; no farm outbuildings	2025 Irrigators	112	41 495,82	33 270,47	0,00	0,00	0,00	163,03	0,00	0,00	0,00	163,03

ID	DESCRIPTION	Year Irrigator	Uniq. Ident.	Parcel Area (m ²)	Crop Areas				Peak Gross Water Volume Requirement per day				
					Vineyard (m ²)	Orchard (m ²)	Nursery (m ²)	Greenhouse (m ²)	Vineyard (m ³)	Orchard (m ³)	Nursery (m ³)	Greenhouse (m ³)	Total (m ³)
113	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	113	40 780,57	32 677,14	0,00	0,00	0,00	160,12	0,00	0,00	0,00	160,12
114	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	114	41 352,45	37 763,27	0,00	0,00	0,00	185,04	0,00	0,00	0,00	185,04
115	Single family detached (not on water)	2025 Irrigators	115	41 373,42	35 060,84	0,00	0,00	0,00	171,80	0,00	0,00	0,00	171,80
116	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	116	41 353,00	33 460,20	0,00	0,00	0,00	163,95	0,00	0,00	0,00	163,95
117	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	117	60 807,50	56 601,09	0,95	0,00	0,00	277,35	0,01	0,00	0,00	277,35
118	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	118	78 966,82	67 496,15	0,00	0,00	0,00	330,73	0,00	0,00	0,00	330,73
119	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	119	82 822,36	42 480,06	0,00	0,00	0,00	208,15	0,00	0,00	0,00	208,15
120		2025 Irrigators	120	191 274,33	167 660,76	0,00	0,00	0,00	821,54	0,00	0,00	0,00	821,54
121	Farm with residence - with or without secondary structures; no farm outbuildings	2025 Irrigators	121	3 715,18	31,46	0,00	0,00	0,00	0,15	0,00	0,00	0,00	0,15
122	Farm with a winery	2021 Irrigators	122	196 685,37	168 684,27	137,72	0,00	0,00	826,55	0,90	0,00	0,00	827,45
123	Farm with residence - with or without secondary structures; no farm outbuildings	2025 Irrigators	123	98 024,60	713,92	94 367,56	0,00	0,00	3,50	613,39	0,00	0,00	616,89
124	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	124	20 173,40	0,00	17 962,99	0,00	0,00	0,00	116,76	0,00	0,00	116,76
125	Farm property without any buildings/structures	2025 Irrigators	125	109 477,81	106 649,23	0,00	0,00	0,00	522,58	0,00	0,00	0,00	522,58
126	Farm property without any buildings/structures	2025 Irrigators	126	83 642,68	80 687,49	2 414,23	0,00	0,00	395,37	15,69	0,00	0,00	411,06
127	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	127	82 782,83	54 527,42	24 930,10	0,00	0,00	267,18	162,05	0,00	0,00	429,23
128	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	128	36 446,31	40,09	33 929,25	0,00	0,00	0,20	220,54	0,00	0,00	220,74
129	Farm with residence - with or without secondary structures; with farm outbuildings	2024 Irrigators	129	11 033,71	0,00	7 065,60	0,00	0,00	0,00	45,93	0,00	0,00	45,93
130	Farm with residence - with or without secondary structures; with farm outbuildings	2021 Irrigators	130	52 558,52	13,88	446,17	0,00	0,00	0,07	2,90	0,00	0,00	2,97
131	Farm property without any buildings/structures	2025 Irrigators	131	45 017,58	42 128,42	0,00	0,00	0,00	206,43	0,00	0,00	0,00	206,43
132	Farm property without any buildings/structures	2025 Irrigators	132	3 713,99	2 554,34	0,00	0,00	0,00	12,52	0,00	0,00	0,00	12,52
133	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	133	395 353,10	88 173,67	196 027,97	0,00	0,00	432,05	1 274,18	0,00	0,00	1 706,23
134	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	134	70 535,58	38 080,19	0,00	0,00	0,00	186,59	0,00	0,00	0,00	186,59
135	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	135	37 349,60	0,00	34 241,74	0,00	0,00	0,00	222,57	0,00	0,00	222,57
136	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	136	40 543,60	0,00	38 031,37	0,00	0,00	0,00	247,20	0,00	0,00	247,20
137	Single family detached (not on water)	2023 Irrigators	137	748,95	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
138	Vacant residential/commercial/ industrial land owned by a non-farmer with a portion being farmed	2023 Irrigators	138	13 145,69	137,07	9 534,33	0,00	0,00	0,67	61,97	0,00	0,00	62,64
139	Farm property without any buildings/structures	2025 Irrigators	139	84 729,22	79 640,48	0,00	0,00	0,00	390,24	0,00	0,00	0,00	390,24
140	Farm property without any buildings/structures	2025 Irrigators	140	78 798,95	73 682,38	0,00	0,00	0,00	361,04	0,00	0,00	0,00	361,04
141	Farm property without any buildings/structures	2025 Irrigators	141	63 614,01	59 323,13	0,00	0,00	0,00	290,68	0,00	0,00	0,00	290,68
142	Bed and breakfast establishment	2025 Irrigators	142	4 643,98	239,45	0,00	0,00	0,00	1,17	0,00	0,00	0,00	1,17
143	Single family detached (not on water)	2025 Irrigators	143	2 255,18	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
144	Farm property without any buildings/structures	2025 Irrigators	144	42 742,54	0,00	38 899,34	0,00	0,00	0,00	252,85	0,00	0,00	252,85
145	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	145	386 204,60	354 749,86	0,00	0,00	0,00	1 738,27	0,00	0,00	0,00	1 738,27
146	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	146	380 526,13	362 901,81	0,00	0,00	0,00	1 778,22	0,00	0,00	0,00	1 778,22
147	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	147	207 132,59	194 176,15	0,00	0,00	0,00	951,46	0,00	0,00	0,00	951,46
148	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	148	190 590,64	175 047,52	0,00	0,00	0,00	857,73	0,00	0,00	0,00	857,73
149	Farm property without any buildings/structures	2025 Irrigators	149	127 665,90	109 338,82	0,00	0,00	0,00	535,76	0,00	0,00	0,00	535,76
150	Farm property without any buildings/structures	2025 Irrigators	150	42 916,12	41 097,20	0,00	0,00	0,00	201,38	0,00	0,00	0,00	201,38
151	Farm property without any buildings/structures	2025 Irrigators	151	26 951,21	26 457,80	0,00	0,00	0,00	129,64	0,00	0,00	0,00	129,64
152	Farm property without any buildings/structures	2025 Irrigators	152	23 191,91	22 223,62	0,00	0,00	0,00	108,90	0,00	0,00	0,00	108,90
153	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	153	40 408,62	22 904,08	10 922,55	0,00	0,00	112,23	71,00	0,00	0,00	183,23
154	Single family detached (not on water)	2025 Irrigators	154	8 706,35	0,00	5 270,93	0,00	0,00	0,00	34,26	0,00	0,00	34,26
155	Farm property without any buildings/structures	2025 Irrigators	155	80 265,80	69 449,98	1 688,66	0,00	0,00	340,30	10,98	0,00	0,00	351,28
156	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	156	34 211,70	0,00	17 790,38	0,00	0,00	0,00	115,64	0,00	0,00	115,64
157	Farm property without any buildings/structures	2023 Irrigators	157	29 977,57	28 968,93	19,60	0,00	0,00	141,95	0,13	0,00	0,00	142,08
158	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	158	95 205,34	87 084,76	0,00	0,00	0,00	426,72	0,00	0,00	0,00	426,72
159	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	159	319 073,03	277 112,72	0,00	0,00	0,00	1 357,85	0,00	0,00	0,00	1 357,85
160	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	160	40 066,52	26 524,33	0,00	0,00	0,00	129,97	0,00	0,00	0,00	129,97
161	Farm with residence - with or without secondary structures; no farm outbuildings	2025 Irrigators	161	287 205,13	271 002,55	620,04	0,00	0,00	1 327,91	4,03	0,00	0,00	1 331,94
162	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	162	36 008,29	31 981,13	0,00	0,00	0,00	156,71	0,00	0,00	0,00	156,71
163	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2021 Irrigators	163	63 297,14	54 775,42	0,00	0,00	0,00	268,40	0,00	0,00	0,00	268,40
164	Farm property without any buildings/structures	2025 Irrigators	164	47 346,65	44 453,78	0,00	0,00	0,00	217,82	0,00	0,00	0,00	217,82
165	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	165	37 946,09	32 976,08	25,48	0,00	0,00	161,58	0,17	0,00	0,00	161,75
166	Farm property without any buildings/structures	2025 Irrigators	166	137 646,99	115 701,63	0,00	0,00	0,00	566,94	0,00	0,00	0,00	566,94
167	Farm with residence - with or without secondary structures; no farm outbuildings	2025 Irrigators	167	70 242,75	22 771,80	0,00	0,00	0,00	111,58	0,00	0,00	0,00	111,58
168	Farm with residence - with or without secondary structures; no farm outbuildings	2025 Irrigators	168	31 883,68	26 203,31	0,00	0,00	0,00	128,40	0,00	0,00	0,00	128,40

ID	DESCRIPTION	Year Irrigator	Uniq. Ident.	Parcel Area (m ²)	Crop Areas				Peak Gross Water Volume Requirement per day				
					Vineyard (m ²)	Orchard (m ²)	Nursery (m ²)	Greenhouse (m ²)	Vineyard (m ³)	Orchard (m ³)	Nursery (m ³)	Greenhouse (m ³)	Total (m ³)
169	Farm with a winery	2025 Irrigators	169	273 717,44	244 509,82	0,00	0,00	0,00	1 198,10	0,00	0,00	0,00	1 198,10
170	Farm property without any buildings/structures	2025 Irrigators	170	120 413,88	116 442,53	0,00	0,00	0,00	570,57	0,00	0,00	0,00	570,57
171	Land owned by a farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	171	132 752,22	124 581,30	0,00	0,00	0,00	610,45	0,00	0,00	0,00	610,45
172	Farm property without any buildings/structures	2025 Irrigators	172	109 591,96	103 304,52	0,00	0,00	0,00	506,19	0,00	0,00	0,00	506,19
173	Farm property without any buildings/structures	2025 Irrigators	173	64 000,79	61 269,91	0,00	0,00	0,00	300,22	0,00	0,00	0,00	300,22
174	Farm property without any buildings/structures	2025 Irrigators	174	51 289,50	49 873,41	0,00	0,00	0,00	244,38	0,00	0,00	0,00	244,38
175	Farm property without any buildings/structures	2025 Irrigators	175	59 693,37	58 780,80	0,00	0,00	0,00	288,03	0,00	0,00	0,00	288,03
176	Farm property without any buildings/structures	2025 Irrigators	176	114 118,21	110 230,80	0,00	0,00	0,00	540,13	0,00	0,00	0,00	540,13
177	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	177	51 415,25	48 769,46	0,00	0,00	0,00	238,97	0,00	0,00	0,00	238,97
178	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	178	74 112,18	71 075,95	0,00	0,00	0,00	348,27	0,00	0,00	0,00	348,27
179	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	179	51 518,07	44 787,86	0,00	0,00	0,00	219,46	0,00	0,00	0,00	219,46
180	Farm property without any buildings/structures	2025 Irrigators	180	51 542,87	22 627,57	0,00	0,00	0,00	110,88	0,00	0,00	0,00	110,88
181	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	181	51 570,60	14 727,74	0,00	0,00	0,00	72,17	0,00	0,00	0,00	72,17
182	Farm with residence - with or without secondary structures; with farm outbuildings	2024 Irrigators	182	84 222,01	62 652,82	9 004,50	0,00	0,00	307,00	58,53	0,00	0,00	365,53
183	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	183	105 504,03	99 904,67	0,00	0,00	0,00	489,53	0,00	0,00	0,00	489,53
184	Farm property without any buildings/structures	2025 Irrigators	184	100 674,12	99 711,34	0,00	0,00	0,00	488,59	0,00	0,00	0,00	488,59
185	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	185	198 621,06	194 775,31	0,00	0,00	0,00	954,40	0,00	0,00	0,00	954,40
186	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	186	88 168,15	57 528,07	0,00	0,00	0,00	281,89	0,00	0,00	0,00	281,89
187	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	187	204 277,30	194 260,90	0,00	0,00	0,00	951,88	0,00	0,00	0,00	951,88
188	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	188	208 162,60	193 099,30	0,00	0,00	0,00	946,19	0,00	0,00	0,00	946,19
189	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	189	89 341,81	81 408,14	0,00	0,00	0,00	398,90	0,00	0,00	0,00	398,90
190	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	190	190 483,85	171 440,13	0,00	0,00	0,00	840,06	0,00	0,00	0,00	840,06
191	Farm property without any buildings/structures	2025 Irrigators	191	119 893,45	118 148,25	0,00	0,00	0,00	578,93	0,00	0,00	0,00	578,93
192	Farm property without any buildings/structures	2025 Irrigators	192	195 135,15	188 972,02	0,00	0,00	0,00	925,96	0,00	0,00	0,00	925,96
193	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	193	103 314,90	79 578,56	0,00	0,00	0,00	389,93	0,00	0,00	0,00	389,93
194	Farm with residence - with or without secondary structures; no farm outbuildings	2025 Irrigators	194	105 927,47	75 700,22	0,00	0,00	0,00	370,93	0,00	0,00	0,00	370,93
195	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	195	170 553,47	152 311,08	0,00	0,00	0,00	746,32	0,00	0,00	0,00	746,32
196	Farm property without any buildings/structures	2025 Irrigators	196	54 147,68	50 698,59	0,00	0,00	0,00	248,42	0,00	0,00	0,00	248,42
197	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	197	116 930,47	103 851,70	0,00	0,00	0,00	508,87	0,00	0,00	0,00	508,87
198	Farm property without any buildings/structures	2025 Irrigators	198	155 127,43	145 666,48	0,00	0,00	0,00	713,77	0,00	0,00	0,00	713,77
199	Single family detached (not on water)	2025 Irrigators	199	4 994,43	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
200	Farm with residence - with commercial/industrial operation	2025 Irrigators	200	43 700,43	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
201	Farm with residence - with or without secondary structures; no farm outbuildings	2021 Irrigators	201	9 291,78	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
202	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	202	119 308,77	769,15	101 245,60	0,00	0,00	3,77	658,10	0,00	0,00	661,87
203	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	203	27 561,26	0,00	21 785,39	0,00	0,00	0,00	141,61	0,00	0,00	141,61
204	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	204	222 777,64	145 242,11	60 902,08	0,00	0,00	711,69	395,86	0,00	0,00	1 107,55
205	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	205	220 013,52	9 083,85	199 047,07	0,00	0,00	44,51	1 293,81	0,00	0,00	1 338,32
206	Farm property without any buildings/structures	2025 Irrigators	206	280 505,80	273 387,02	0,00	0,00	0,00	1 339,60	0,00	0,00	0,00	1 339,60
207	Farm property without any buildings/structures	2025 Irrigators	207	77 108,76	72 464,40	0,00	0,00	0,00	355,08	0,00	0,00	0,00	355,08
208	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	208	36 168,36	509,89	29 589,97	0,00	0,00	2,50	192,33	0,00	0,00	194,83
209	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	209	222 941,96	216 307,79	130,01	0,00	0,00	1 059,91	0,85	0,00	0,00	1 060,75
210	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	210	190 612,42	156 667,26	20 159,22	0,00	0,00	767,67	131,03	0,00	0,00	898,70
211	Farm property without any buildings/structures	2025 Irrigators	211	109 866,57	105 588,84	0,00	0,00	0,00	517,39	0,00	0,00	0,00	517,39
212	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	212	287 136,15	241 657,46	36 541,03	0,00	0,00	1 184,12	237,52	0,00	0,00	1 421,64
213	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	213	445 565,75	432 240,90	0,00	0,00	0,00	2 117,98	0,00	0,00	0,00	2 117,98
214	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	214	174 403,86	147 331,58	858,42	0,00	0,00	721,92	5,58	0,00	0,00	727,50
215	Farm property without any buildings/structures	2025 Irrigators	215	103 174,16	33 238,48	68 189,39	0,00	0,00	162,87	443,23	0,00	0,00	606,10
216	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	216	62 513,85	0,00	15 651,98	0,00	0,00	0,00	101,74	0,00	0,00	101,74
217	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	217	184 501,78	175 568,65	0,00	0,00	0,00	860,29	0,00	0,00	0,00	860,29
218	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	218	214 127,57	203 441,58	0,00	0,00	0,00	996,86	0,00	0,00	0,00	996,86
219	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	219	207 683,19	167 271,97	0,00	0,00	0,00	819,63	0,00	0,00	0,00	819,63
220	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	220	187 808,04	148 978,48	0,00	0,00	0,00	729,99	0,00	0,00	0,00	729,99
221	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	221	399 427,13	382 314,13	0,00	0,00	0,00	1 873,34	0,00	0,00	0,00	1 873,34
222	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	222	278 692,89	242 765,17	0,00	0,00	0,00	1 189,55	0,00	0,00	0,00	1 189,55
223	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	223	38 294,31	7,98	33 583,47	0,00	0,00	0,04	218,29	0,00	0,00	218,33
224	Farm property without any buildings/structures	2025 Irrigators	224	102 282,24	0,00	98 528,72	0,00	0,00	0,00	640,44	0,00	0,00	640,44

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					Vineyard (m ²)	Orchard (m ²)	Nursery (m ²)	Greenhouse (m ²)	Vineyard (m ³)	Orchard (m ³)	Nursery (m ³)	Greenhouse (m ³)	Total (m ³)
225	Farm property without any buildings/structures	2025 Irrigators	225	145 335,65	0,00	138 038,69	0,00	0,00	0,00	897,25	0,00	0,00	897,25
226	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	226	57 382,04	199,15	51 287,27	0,00	0,00	0,98	333,37	0,00	0,00	334,34
227	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	227	169 458,08	26 495,90	72 786,21	0,00	0,00	129,83	473,11	0,00	0,00	602,94
228	Farm property without any buildings/structures	2025 Irrigators	228	82 076,88	51 688,25	22 731,32	0,00	0,00	253,27	147,75	0,00	0,00	401,03
229	Farm property without any buildings/structures	2025 Irrigators	229	93 118,71	1 271,41	90 514,83	0,00	0,00	6,23	588,35	0,00	0,00	594,58
230	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	230	13 499,39	709,40	12 719,04	0,00	0,00	3,48	82,67	0,00	0,00	86,15
231	Farm property without any buildings/structures	2025 Irrigators	231	95 626,90	0,00	75 280,11	0,00	0,00	0,00	489,32	0,00	0,00	489,32
232	Vacant residential/commercial/ industrial land owned by a non-farmer with a portion being farmed	2025 Irrigators	232	71 683,91	0,00	55 842,88	0,00	0,00	0,00	362,98	0,00	0,00	362,98
233	Farm property without any buildings/structures	2025 Irrigators	233	111 407,35	107 452,65	70,03	0,00	0,00	526,52	0,46	0,00	0,00	526,97
234	Farm property without any buildings/structures	2025 Irrigators	234	109 689,70	109 231,53	0,00	0,00	0,00	535,23	0,00	0,00	0,00	535,23
235	Farm property without any buildings/structures	2021 Irrigators	235	22 381,79	12 943,83	121,25	0,00	0,00	63,42	0,79	0,00	0,00	64,21
236	Farm property without any buildings/structures	2021 Irrigators	236	63 502,71	34 760,64	1 910,44	0,00	0,00	170,33	12,42	0,00	0,00	182,74
237	Farm property without any buildings/structures	2021 Irrigators	237	73 152,38	71 795,36	135,55	0,00	0,00	351,80	0,88	0,00	0,00	352,68
238	Vacant residential/commercial/ industrial land owned by a non-farmer with a portion being farmed	2021 Irrigators	238	102 180,62	100 599,54	64,71	0,00	0,00	492,94	0,42	0,00	0,00	493,36
239	Farm property without any buildings/structures	2021 Irrigators	239	87 366,91	64 883,29	1 136,67	0,00	0,00	317,93	7,39	0,00	0,00	325,32
240	Farm property without any buildings/structures	2023 Irrigators	240	38 143,69	37 605,47	77,46	0,00	0,00	184,27	0,50	0,00	0,00	184,77
241	Farm property without any buildings/structures	2025 Irrigators	241	66 325,01	0,00	0,00	27 667,78	0,00	0,00	0,00	583,79	0,00	583,79
242	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	242	93 581,33	5 530,69	519,89	21 406,01	8 900,57	27,10	3,38	451,67	89,01	571,15
243	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	243	20 347,63	0,00	0,00	2 532,12	2 008,04	0,00	0,00	53,43	20,08	73,51
244	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	244	34 358,02	0,00	34,30	0,00	12 534,43	0,00	0,22	0,00	125,34	125,57
245	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	245	208 597,95	196 896,03	0,00	0,00	0,00	964,79	0,00	0,00	0,00	964,79
246	Vacant residential/commercial/ industrial land owned by a non-farmer with a portion being farmed	2025 Irrigators	246	55 947,87	55 081,99	0,00	0,00	0,00	269,90	0,00	0,00	0,00	269,90
247	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	247	72 841,50	62 765,98	0,00	0,00	0,00	307,55	0,00	0,00	0,00	307,55
248	Farm property without any buildings/structures	2025 Irrigators	248	161 490,97	151 695,42	0,00	0,00	0,00	743,31	0,00	0,00	0,00	743,31
249	Vacant residential/commercial/ industrial land owned by a non-farmer with a portion being farmed	2025 Irrigators	249	217 700,98	208 880,87	0,00	0,00	0,00	1 023,52	0,00	0,00	0,00	1 023,52
250	Farm property without any buildings/structures	2025 Irrigators	250	207 591,04	201 483,29	0,00	0,00	0,00	987,27	0,00	0,00	0,00	987,27
251	Vacant residential land not on water	2025 Irrigators	251	45 178,12	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
252	Vacant residential land not on water	2025 Irrigators	252	72 477,38	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
253	Vacant residential land not on water	2025 Irrigators	253	6 934,25	6 205,72	0,00	0,00	0,00	30,41	0,00	0,00	0,00	30,41
254	Vacant residential land not on water	2025 Irrigators	254	22 281,23	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
255	Vacant residential land not on water	2025 Irrigators	255	252 961,67	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
256	Vacant residential land not on water	2025 Irrigators	256	14 153,66	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
257	Vacant residential land not on water	2025 Irrigators	257	34 384,71	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
258	Vacant residential land not on water	2021 Irrigators	258	40 830,81	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
259	Vacant residential land not on water	2023 Irrigators	259	42 893,36	1 037,26	0,00	0,00	0,00	5,08	0,00	0,00	0,00	5,08
260	Vacant residential land not on water	2023 Irrigators	260	21 791,96	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
261	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2022 Irrigators	261	202 374,20	149 375,80	0,00	0,00	0,00	731,94	0,00	0,00	0,00	731,94
262	Farm without residence - with secondary structures; with farm outbuildings	2021 Irrigators	262	100 658,90	92 836,79	0,00	0,00	0,00	454,90	0,00	0,00	0,00	454,90
263	Farm without residence - with secondary structures; with farm outbuildings	2021 Irrigators	263	100 301,83	96 219,99	0,00	0,00	0,00	471,48	0,00	0,00	0,00	471,48
264	Vacant residential/commercial/ industrial land owned by a non-farmer with a portion being farmed	2024 Irrigators	264	161 697,47	151 021,01	0,00	0,00	0,00	740,00	0,00	0,00	0,00	740,00
265	Large scale greenhouse operation	2025 Irrigators	265	828 321,67	0,00	0,00	0,00	331 955,76	0,00	0,00	0,00	3 319,56	3 319,56
266	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	266	223 787,62	198 113,70	0,00	0,00	0,00	970,76	0,00	0,00	0,00	970,76
267	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	267	4 533,14	115,64	0,00	0,00	0,00	0,57	0,00	0,00	0,00	0,57
268	Farm property without any buildings/structures	2025 Irrigators	268	94 116,58	88 023,63	69,26	0,00	0,00	431,32	0,45	0,00	0,00	431,77
269	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	269	20 388,68	0,00	15 734,79	0,00	0,00	0,00	102,28	0,00	0,00	102,28
270	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	270	52 596,16	47 046,49	709,30	0,00	0,00	230,53	4,61	0,00	0,00	235,14
271	Farm property without any buildings/structures	2025 Irrigators	271	105 913,23	102 037,41	0,00	0,00	0,00	499,98	0,00	0,00	0,00	499,98
272	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	272	113 655,84	104 321,15	0,00	0,00	0,00	511,17	0,00	0,00	0,00	511,17
273	Farm property without any buildings/structures	2025 Irrigators	273	167 794,42	152 672,32	0,00	0,00	0,00	748,09	0,00	0,00	0,00	748,09
274	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	274	99 885,09	78 967,24	0,00	0,00	0,00	386,94	0,00	0,00	0,00	386,94
275	Farm property without any buildings/structures	2025 Irrigators	275	78 073,45	69 204,84	0,00	0,00	0,00	339,10	0,00	0,00	0,00	339,10
276	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	276	98 765,66	27,83	93 820,53	0,00	0,00	0,14	609,83	0,00	0,00	609,97
277	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	277	45 477,67	8 744,37	26 550,54	0,00	0,00	42,85	172,58	0,00	0,00	215,43
278	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	278	50 088,25	15 898,15	22 821,10	0,00	0,00	77,90	148,34	0,00	0,00	226,24
279	Farm with residence - with or without secondary structures; with farm outbuildings	2024 Irrigators	279	73 601,55	65 683,78	0,00	0,00	0,00	321,85	0,00	0,00	0,00	321,85
280	Farm property without any buildings/structures	2025 Irrigators	280	98 080,41	92 503,48	0,00	0,00	0,00	453,27	0,00	0,00	0,00	453,27

ID	DESCRIPTION	Year Irrigator	Uniq. Ident.	Parcel Area (m ²)	Crop Areas				Peak Gross Water Volume Requirement per day				
					Vineyard (m ²)	Orchard (m ²)	Nursery (m ²)	Greenhouse (m ²)	Vineyard (m ³)	Orchard (m ³)	Nursery (m ³)	Greenhouse (m ³)	Total (m ³)
281	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	281	91 389,90	81 052,02	0,00	0,00	0,00	397,15	0,00	0,00	0,00	397,15
282	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	282	172 135,71	141 506,22	0,00	0,00	0,00	693,38	0,00	0,00	0,00	693,38
283	Farm with residence - with or without secondary structures; with farm outbuildings	2020 Irrigators	283	33 944,66	0,00	8 500,70	0,00	8 684,36	0,00	55,25	0,00	86,84	142,10
284	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	284	39 130,61	30 436,17	0,00	0,00	0,00	149,14	0,00	0,00	0,00	149,14
285	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	285	80 358,77	0,00	32 191,91	0,00	0,00	0,00	209,25	0,00	0,00	209,25
286	Farm property without any buildings/structures	2025 Irrigators	286	81 702,09	0,00	80 169,91	0,00	0,00	0,00	521,10	0,00	0,00	521,10
287	Farm with residence - with or without secondary structures; no farm outbuildings	2025 Irrigators	287	44 541,52	0,00	12 825,57	0,00	0,00	0,00	83,37	0,00	0,00	83,37
288	Farm property without any buildings/structures	2025 Irrigators	288	71 815,71	66 030,29	986,93	0,00	0,00	323,55	6,42	0,00	0,00	329,96
289	Farm property without any buildings/structures	2025 Irrigators	289	91 491,98	60 911,25	22 211,34	0,00	0,00	298,47	144,37	0,00	0,00	442,84
290	Single family detached (not on water)	2025 Irrigators	290	6 621,79	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
291	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	291	290 060,47	231 322,33	22 445,76	0,00	0,00	1 133,48	145,90	0,00	0,00	1 279,38
292	Farm with residence - with or without secondary structures; with farm outbuildings	2023 Irrigators	292	30 326,59	9,45	25 490,35	0,00	0,00	0,05	165,69	0,00	0,00	165,73
293	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	293	19 158,79	15 174,64	0,00	0,00	0,00	74,36	0,00	0,00	0,00	74,36
294	Farm property without any buildings/structures	2025 Irrigators	294	26 633,23	25 141,19	0,00	0,00	0,00	123,19	0,00	0,00	0,00	123,19
295	Farm property without any buildings/structures	2025 Irrigators	295	36 726,88	34 850,58	0,00	0,00	0,00	170,77	0,00	0,00	0,00	170,77
296	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	296	36 396,29	30 241,55	0,00	0,00	0,00	148,18	0,00	0,00	0,00	148,18
297	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	297	42 624,47	33 174,81	0,00	0,00	0,00	162,56	0,00	0,00	0,00	162,56
298	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	298	95 493,21	0,00	82 972,01	0,00	0,00	0,00	539,32	0,00	0,00	539,32
299	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	299	156 876,17	45 057,99	96 572,52	0,00	0,00	220,78	627,72	0,00	0,00	848,51
300	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	300	163 266,34	145 634,27	3 222,13	0,00	0,00	713,61	20,94	0,00	0,00	734,55
301	Farm without residence - with secondary structures; with farm outbuildings	2021 Irrigators	301	3 922,52	615,33	0,00	0,00	0,00	3,02	0,00	0,00	0,00	3,02
302	Farm with residence - with or without secondary structures; with farm outbuildings	2021 Irrigators	302	78 671,59	69 490,80	0,00	0,00	0,00	340,50	0,00	0,00	0,00	340,50
303	Large scale greenhouse operation	2025 Irrigators	303	121 379,52	0,00	0,00	12 697,28	32 255,87	0,00	0,00	267,91	322,56	590,47
304	Farm with residence - with or without secondary structures; with farm outbuildings	2022 Irrigators	304	40 608,77	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
305	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	305	80 277,88	0,00	0,00	1 917,20	22 370,03	0,00	0,00	40,45	223,70	264,15
306	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	306	58 444,56	50 094,24	0,00	0,00	0,00	245,46	0,00	0,00	0,00	245,46
307	Farm with a winery	2025 Irrigators	307	184 244,54	166 381,81	0,00	0,00	0,00	815,27	0,00	0,00	0,00	815,27
308	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	308	118 248,38	110 019,45	0,00	0,00	0,00	539,10	0,00	0,00	0,00	539,10
309	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	309	31 847,82	20 296,39	0,00	0,00	0,00	99,45	0,00	0,00	0,00	99,45
310	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	310	43 268,33	33 272,97	0,00	0,00	0,00	163,04	0,00	0,00	0,00	163,04
311	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	311	100 779,62	94 305,02	0,00	0,00	0,00	462,09	0,00	0,00	0,00	462,09
312	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	312	107 997,63	93 891,42	58,74	0,00	0,00	460,07	0,38	0,00	0,00	460,45
313	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	313	183 084,61	23 011,09	8 351,45	0,00	0,00	112,75	54,28	0,00	0,00	167,04
314	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	314	40 475,36	41,02	29 486,42	0,00	0,00	0,20	191,66	0,00	0,00	191,86
315	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	315	87 985,53	33 658,98	31 123,89	0,00	0,00	164,93	202,31	0,00	0,00	367,23
316	Farm with residence - with commercial/industrial operation	2025 Irrigators	316	72 140,01	50 490,18	0,00	0,00	0,00	247,40	0,00	0,00	0,00	247,40
317	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	317	96 934,66	68 331,90	0,00	0,00	0,00	334,83	0,00	0,00	0,00	334,83
318	Farm property without any buildings/structures	2025 Irrigators	318	39 356,98	39 356,98	0,00	0,00	0,00	192,85	0,00	0,00	0,00	192,85
319	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	319	6 199,79	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
320	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	320	88 657,76	88 657,76	0,00	0,00	0,00	434,42	0,00	0,00	0,00	434,42
321	Farm property without any buildings/structures	2025 Irrigators	321	50 049,21	50 049,21	0,00	0,00	0,00	245,24	0,00	0,00	0,00	245,24
322	Farm property without any buildings/structures	2025 Irrigators	322	52 029,56	52 029,56	0,00	0,00	0,00	254,94	0,00	0,00	0,00	254,94
323	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	323	260 135,30	249 210,03	0,00	0,00	0,00	1 221,13	0,00	0,00	0,00	1 221,13
324	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	324	49 045,74	44 816,24	0,00	0,00	0,00	219,60	0,00	0,00	0,00	219,60
325	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	325	135 482,94	127 621,64	0,00	0,00	0,00	625,35	0,00	0,00	0,00	625,35
326	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	326	2 054,81	1 307,38	0,00	0,00	0,00	6,41	0,00	0,00	0,00	6,41
327	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	327	60 734,14	51 699,50	0,00	0,00	0,00	253,33	0,00	0,00	0,00	253,33
328	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	328	82 106,92	68 294,13	0,00	0,00	0,00	334,64	0,00	0,00	0,00	334,64
329	Farm with residence - with or without secondary structures; no farm outbuildings	2025 Irrigators	329	19 452,64	13 918,49	0,00	0,00	0,00	68,20	0,00	0,00	0,00	68,20
330	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	330	35 950,64	27 069,32	0,00	0,00	0,00	132,64	0,00	0,00	0,00	132,64
331	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	331	40 365,35	33 007,38	0,00	0,00	0,00	161,74	0,00	0,00	0,00	161,74
332	Farm property without any buildings/structures	2025 Irrigators	332	124 137,25	119 849,63	0,00	0,00	0,00	587,26	0,00	0,00	0,00	587,26
333	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	333	217 038,08	187 318,17	0,00	0,00	0,00	917,86	0,00	0,00	0,00	917,86
334	Farm property without any buildings/structures	2025 Irrigators	334	321 165,17	227 893,38	0,00	0,00	0,00	1 116,68	0,00	0,00	0,00	1 116,68
335	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	335	47 110,39	41 889,68	0,00	0,00	0,00	205,26	0,00	0,00	0,00	205,26
336	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	336	84 171,54	67 620,95	0,00	0,00	0,00	331,34	0,00	0,00	0,00	331,34

ID	DESCRIPTION	Year Irrigator	Uniq. Ident.	Parcel Area (m ²)	Crop Areas				Peak Gross Water Volume Requirement per day				
					Vineyard (m ²)	Orchard (m ²)	Nursery (m ²)	Greenhouse (m ²)	Vineyard (m ³)	Orchard (m ³)	Nursery (m ³)	Greenhouse (m ³)	Total (m ³)
337	Vacant residential/commercial/ industrial land owned by a non-farmer with a portion being farmed	2025 Irrigators	337	155 562,64	0,00	107 752,68	0,00	0,00	0,00	700,39	0,00	0,00	700,39
338	Farm with a winery	2025 Irrigators	338	123 240,90	101 973,14	0,00	0,00	0,00	499,67	0,00	0,00	0,00	499,67
339	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	339	60 614,62	0,00	53 286,16	0,00	0,00	0,00	346,36	0,00	0,00	346,36
340	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	340	80 524,10	20 501,12	53 055,80	0,00	0,00	100,46	344,86	0,00	0,00	445,32
341	Vacant residential/commercial/ industrial land owned by a non-farmer with a portion being farmed	2025 Irrigators	341	202 307,61	199 116,28	10,34	0,00	0,00	975,67	0,07	0,00	0,00	975,74
342	Farm property without any buildings/structures	2025 Irrigators	342	40 411,82	0,00	40 411,82	0,00	0,00	0,00	262,68	0,00	0,00	262,68
343	Farm property without any buildings/structures	2025 Irrigators	343	126 374,34	125 189,57	0,00	0,00	0,00	613,43	0,00	0,00	0,00	613,43
344	Farm with residence - with or without secondary structures; no farm outbuildings	2025 Irrigators	344	85 067,56	78 426,52	0,00	0,00	0,00	384,29	0,00	0,00	0,00	384,29
345	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	345	41 217,44	28 741,95	139,20	0,00	0,00	140,84	0,90	0,00	0,00	141,74
346	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	346	32 795,42	26 583,08	0,00	0,00	0,00	130,26	0,00	0,00	0,00	130,26
347	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	347	123 507,76	115 443,13	736,41	0,00	0,00	565,67	4,79	0,00	0,00	570,46
348	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	348	17 319,70	13 884,74	0,00	0,00	0,00	68,04	0,00	0,00	0,00	68,04
349	Farm with residence - with or without secondary structures; with farm outbuildings	2024 Irrigators	349	58 496,91	44 097,92	0,00	0,00	0,00	216,08	0,00	0,00	0,00	216,08
350	Farm property without any buildings/structures	2020 Irrigators	350	93 188,74	171,67	80 946,09	0,00	0,00	0,84	526,15	0,00	0,00	526,99
351	Farm without residence - with secondary structures; with farm outbuildings	2024 Irrigators	351	63 200,59	0,00	57 951,83	0,00	0,00	0,00	376,69	0,00	0,00	376,69
352	Single family detached (not on water)	2024 Irrigators	352	5 754,34	0,00	4 145,33	0,00	0,00	0,00	26,94	0,00	0,00	26,94
353	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	353	24 274,00	19 275,38	0,00	0,00	0,00	94,45	0,00	0,00	0,00	94,45
354	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	354	60 282,26	44 818,60	0,00	0,00	0,00	219,61	0,00	0,00	0,00	219,61
355	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	355	45 342,16	3,30	41 100,51	0,00	0,00	0,02	267,15	0,00	0,00	267,17
356	Farm without residence - with secondary structures; with farm outbuildings	2021 Irrigators	356	56 777,44	0,00	55 376,53	0,00	0,00	0,00	359,95	0,00	0,00	359,95
357	Farm with residence - with or without secondary structures; with farm outbuildings	2021 Irrigators	357	34 008,63	0,00	26 193,07	0,00	0,00	0,00	170,25	0,00	0,00	170,25
358	Farm property without any buildings/structures	2025 Irrigators	358	110 593,82	283,77	106 816,79	0,00	0,00	1,39	694,31	0,00	0,00	695,70
359	Farm with residence - with or without secondary structures; with farm outbuildings	2021 Irrigators	359	109 325,13	0,00	87 778,50	0,00	0,00	0,00	570,56	0,00	0,00	570,56
360	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	360	87 877,28	0,00	80 077,94	0,00	0,00	0,00	520,51	0,00	0,00	520,51
361	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	361	29 304,77	193,74	25 379,40	0,00	0,00	0,95	164,97	0,00	0,00	165,92
362	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	362	24 270,65	0,00	1,32	0,00	0,00	0,00	0,01	0,00	0,00	0,01
363	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	363	84 656,20	77 841,73	1 922,77	0,00	0,00	381,42	12,50	0,00	0,00	393,92
364	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	364	109 912,27	191,31	99 224,98	0,00	0,00	0,94	644,96	0,00	0,00	645,90
365	Farm with residence - with or without secondary structures; no farm outbuildings	2025 Irrigators	365	44 471,39	657,49	36 646,83	0,00	0,00	3,22	238,20	0,00	0,00	241,43
366	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	366	374 738,19	115 238,74	249 133,23	0,00	0,00	564,67	1 619,37	0,00	0,00	2 184,04
367	Farm property without any buildings/structures	2025 Irrigators	367	101 654,61	0,00	101 324,18	0,00	0,00	0,00	658,61	0,00	0,00	658,61
368	Farm property without any buildings/structures	2025 Irrigators	368	161 845,11	50 189,21	108 728,74	0,00	0,00	245,93	706,74	0,00	0,00	952,66
369	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	369	33 878,79	14 554,34	13 464,75	0,00	0,00	71,32	87,52	0,00	0,00	158,84
370	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	370	175 135,50	164 603,77	13,47	0,00	0,00	806,56	0,09	0,00	0,00	806,65
371	Farm property without any buildings/structures	2025 Irrigators	371	176 531,89	52 697,89	110 963,40	0,00	0,00	258,22	721,26	0,00	0,00	979,48
372	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	372	54 500,32	24 331,63	23 529,80	0,00	0,00	119,22	152,94	0,00	0,00	272,17
373	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	373	62 804,25	10 753,74	48 768,46	0,00	0,00	52,69	316,99	0,00	0,00	369,69
374	Farm property without any buildings/structures	2025 Irrigators	374	93 784,08	0,00	90 212,61	0,00	0,00	0,00	586,38	0,00	0,00	586,38
375	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	375	225 579,93	0,00	217 960,08	0,00	0,00	0,00	1 416,74	0,00	0,00	1 416,74
376	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	376	28 115,23	12 785,12	2 925,14	0,00	0,00	62,65	19,01	0,00	0,00	81,66
377	Farm property without any buildings/structures	2025 Irrigators	377	35 402,65	33 645,98	0,00	0,00	0,00	164,87	0,00	0,00	0,00	164,87
378	Farm property without any buildings/structures	2025 Irrigators	378	186 310,05	172 499,14	196,91	0,00	0,00	845,25	1,28	0,00	0,00	846,53
379	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	379	71 355,84	0,00	66 188,78	0,00	0,00	0,00	430,23	0,00	0,00	430,23
380	Farm property without any buildings/structures	2025 Irrigators	380	82 382,56	80 683,69	710,70	0,00	0,00	395,35	4,62	0,00	0,00	399,97
381	Farm property without any buildings/structures	2025 Irrigators	381	88 515,70	82 151,79	117,17	0,00	0,00	402,54	0,76	0,00	0,00	403,31
382	Farm property without any buildings/structures	2025 Irrigators	382	85 519,36	81 478,75	0,00	0,00	0,00	399,25	0,00	0,00	0,00	399,25
383	Farm property without any buildings/structures	2025 Irrigators	383	36 428,29	32 787,11	0,00	0,00	0,00	160,66	0,00	0,00	0,00	160,66
384	Farm with residence - with or without secondary structures; with farm outbuildings	2025 Irrigators	384	16 547,06	10 162,19	433,01	0,00	0,00	49,79	2,81	0,00	0,00	52,61
385	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed	2025 Irrigators	385	48 862,62	0,00	42 727,01	0,00	0,00	0,00	277,73	0,00	0,00	277,73
388	Farm property without any buildings/structures	2024 Irrigators	388	99 524,65	0,00	86 505,28	0,00	0,00	0,00	562,28	0,00	0,00	562,28
389	Farm without residence - with secondary structures; with farm outbuildings	2025 Irrigators	389	76 232,69	68 535,26	0,00	0,00	0,00	335,82	0,00	0,00	0,00	335,82
390	Farm with residence - with or without secondary structures; no farm outbuildings	2025 Irrigators	390	39 130,99	29 916,28	0,00	0,00	0,00	146,59	0,00	0,00	0,00	146,59
391	Farm with a winery	2025 Irrigators	391	218 281,78	108 188,00	0,00	0,00	0,00	530,12	0,00	0,00	0,00	530,12
392	Golf course	2025 Irrigators	392	193 495,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
393		2021 Irrigators	393	32 899,26	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
394	Farm property without any buildings/structures	2025 Irrigators	394	18 141,24	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

1 257,72

ID	DESCRIPTION	Year Irrigator	Uniq. Ident.	Parcel Area (m ²)	Crop Areas				Peak Gross Water Volume Requirement per day					
					Vineyard (m ²)	Orchard (m ²)	Nursery (m ²)	Greenhouse (m ²)	Vineyard (m ³)	Orchard (m ³)	Nursery (m ³)	Greenhouse (m ³)	Total (m ³)	
395	Farm property without any buildings/structures	2025 Irrigators	395	190 394,20	173 605,00	0,00	0,00	0,00	850,66	0,00	0,00	0,00	850,66	
396	Farm property without any buildings/structures	2025 Irrigators	396	91 994,37	61 064,93	0,00	0,00	0,00	299,22	0,00	0,00	0,00	299,22	
397	Farm property without any buildings/structures	2025 Irrigators	397	144 549,35	132 920,71	0,00	0,00	0,00	651,31	0,00	0,00	0,00	651,31	
398	Farm property without any buildings/structures	2025 Irrigators	398	109 373,01	93 671,09	0,00	0,00	0,00	458,99	0,00	0,00	0,00	458,99	
399	Farm property without any buildings/structures	2025 Irrigators	399	109 385,78	102 099,57	0,00	0,00	0,00	500,29	0,00	0,00	0,00	500,29	
400	Farm property without any buildings/structures	2025 Irrigators	400	165 906,09	138 139,76	0,00	0,00	0,00	676,88	0,00	0,00	0,00	676,88	
401		2025 Irrigators	401	38 396,09	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
402		2023 Irrigators	402	28 514,18	628,59	27 885,59	0,00	0,00	3,08	181,26	0,00	0,00	184,34	
403		2021 Irrigators	403	10 833,75	0,00	7 411,95	0,00	0,00	0,00	48,18	0,00	0,00	48,18	
404		2022 Irrigators	404	112 103,05	103 529,60	0,00	0,00	0,00	507,30	0,00	0,00	0,00	507,30	
405		2022 Irrigators	405	44 583,06	42 120,97	0,00	0,00	0,00	206,39	0,00	0,00	0,00	206,39	
406		2022 Irrigators	406	44 735,68	0,00	41 983,34	0,00	0,00	0,00	272,89	0,00	0,00	272,89	
407		2022 Irrigators	407	18 072,90	0,00	14 154,90	0,00	0,00	0,00	92,01	0,00	0,00	92,01	
408		2025 Irrigators	408	56 502,07	0,00	55 495,15	0,00	0,00	0,00	360,72	0,00	0,00	360,72	
409		2025 Irrigators	409	21 698,50	0,00	18 808,03	0,00	0,00	0,00	122,25	0,00	0,00	122,25	
410		2022 Irrigators	410	90 340,08	85 791,47	13,26	0,00	0,00	420,38	0,09	0,00	0,00	420,46	
411		2022 Irrigators	411	31 880,31	0,00	0,00	12 539,17	2 763,32	0,00	0,00	264,58	27,63	292,21	
Golf Courses Total area :				193 495,01									166 600,83	166 600,83
														167 858,55
412	New East Area - Dee Road		412	682 258,48	269 238,58	32 604,90			1 319,27	211,93			1 531,20	
386	Golf course	2025 Irrigators	386	145 078,79	0,00	0,00	0,00	0,00	0,00		0,00	0,00	0,00	943,01
387	Golf course	2025 Irrigators	387	43 269,11	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	281,25
													1 531,20	1 531,20
														2 755,46
New West Area - Eastchester														
413	Farm with residence - with or without secondary structures; with farm outbuildings		413	125 946,30	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
414	Farm without residence - with secondary structures; with farm outbuildings		414	310 266,75	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
415	Farm with residence - with or without secondary structures; with farm outbuildings		415	384 849,69	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
416	Farm with residence - with or without secondary structures; with farm outbuildings		416	62 140,32	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
417	Farm with residence - with or without secondary structures; with farm outbuildings		417	124 915,19	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
418	Managed forest property, residence not on water		418	57 188,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
419	Farm without residence - with secondary structures; with farm outbuildings		419	186 308,13	124 114,40	0,00	0,00	0,00	608,16	0,00	0,00	0,00	608,16	
420	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed		420	403 908,25	108 820,24	0,00	0,00	0,00	533,22	0,00	0,00	0,00	533,22	
421	Farm with a winery		421	67 036,90	57 465,83	0,00	0,00	0,00	281,58	0,00	0,00	0,00	281,58	
422	Farm with residence - with or without secondary structures; with farm outbuildings		422	97 741,07	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
423	Farm without residence - with secondary structures; with farm outbuildings		423	187 756,76	66 594,03	0,00	0,00	0,00	326,31	0,00	0,00	0,00	326,31	
424	Vacant residential/commercial/ industrial land owned by a non-farmer with a portion being farmed		424	386 846,43	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
425	Vacant residential/commercial/ industrial land owned by a non-farmer with a portion being farmed		425	540 874,33	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
426	Vacant residential/commercial/ industrial land owned by a non-farmer with a portion being farmed		426	656 740,82	447 077,15	0,00	0,00	0,00	2 190,68	0,00	0,00	0,00	2 190,68	
427	Farm property without any buildings/structures		427	101 979,70	95 796,41	0,00	0,00	0,00	469,40	0,00	0,00	0,00	469,40	
428	Farm without residence - with secondary structures; with farm outbuildings		428	168 276,41	143 481,38	0,00	0,00	0,00	703,06	0,00	0,00	0,00	703,06	
429	Farm with residence - with or without secondary structures; with farm outbuildings		429	60 321,58	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
430	Farm with residence - with or without secondary structures; with farm outbuildings		430	158 360,88	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
431	Farm with residence - with or without secondary structures; with farm outbuildings		431	141 737,25	63 719,76	0,00	0,00	0,00	312,23	0,00	0,00	0,00	312,23	
432	Farm property without any buildings/structures		432	146 252,81	84 055,32	0,00	0,00	0,00	411,87	0,00	0,00	0,00	411,87	
433	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed		433	40 777,97	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
434	Farm with residence - with or without secondary structures; with farm outbuildings		434	151 777,46	98 447,79	0,00	0,00	0,00	482,39	0,00	0,00	0,00	482,39	
435	Farm with residence - with or without secondary structures; with farm outbuildings		435	383 841,43	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
436	Farm with residence - with or without secondary structures; no farm outbuildings		436	6 066,89	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
437	Farm without residence - with secondary structures; with farm outbuildings		437	171 619,97	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
438	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed		438	18 875,77	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
439	Farm with residence - with or without secondary structures; with farm outbuildings		439	112 953,26	53 406,45	0,00	0,00	0,00	261,69	0,00	0,00	0,00	261,69	
440	Farm with residence - with or without secondary structures; with farm outbuildings		440	81 484,10	48 691,40	0,00	0,00	0,00	238,59	0,00	0,00	0,00	238,59	
441	Farm with residence - with or without secondary structures; with farm outbuildings		441	363 379,07	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	
442	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed		442	36 892,94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	

ID	DESCRIPTION	Year Irrigator	Uniq. Ident.	Parcel Area (m ²)	Crop Areas				Peak Gross Water Volume Requirement per day					
					Vineyard (m ²)	Orchard (m ²)	Nursery (m ²)	Greenhouse (m ²)	Vineyard (m ³)	Orchard (m ³)	Nursery (m ³)	Greenhouse (m ³)	Total (m ³)	
443	Farm property without any buildings/structures		443	4 048,14	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
444	Farm with residence - with or without secondary structures; with farm outbuildings		444	58 608,89	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
445	Farm with residence - with or without secondary structures; no farm outbuildings		445	4 904,04	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
446	Farm with residence - with or without secondary structures; no farm outbuildings		446	49 631,46	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
447	Farm with residence - with or without secondary structures; no farm outbuildings		447	40 382,46	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
448	Farm with residence - with or without secondary structures; with farm outbuildings		448	193 576,39	64 594,59	0,00	0,00	0,00	0,00	316,51	0,00	0,00	0,00	316,51
449	Farm with residence - with or without secondary structures; with farm outbuildings		449	15 909,85	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
450	Farm with residence - with or without secondary structures; with farm outbuildings		450	358 859,09	347 819,85	0,00	0,00	0,00	0,00	1 704,32	0,00	0,00	0,00	1 704,32
451	Farm with residence - with or without secondary structures; with farm outbuildings		451	204 749,83	184 228,66	0,00	0,00	0,00	0,00	902,72	0,00	0,00	0,00	902,72
452	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed		452	204 940,41	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
453	Farm with residence - with or without secondary structures; with farm outbuildings		453	288 839,51	0,00	0,00	0,00	9 469,58	0,00	0,00	0,00	94,70	0,00	94,70
454	Farm property without any buildings/structures		454	347 556,28	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
455	Farm with residence - with commercial/industrial operation		455	88 160,82	0,00	17 591,27	0,00	0,00	0,00	0,00	114,34	0,00	0,00	114,34
456	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed		456	40 974,59	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
457	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed		457	89 220,96	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
458	Farm without residence - with secondary structures; with farm outbuildings		458	414 843,85	361 890,92	0,00	0,00	0,00	0,00	1 773,27	0,00	0,00	0,00	1 773,27
459	Farm with residence - with or without secondary structures; no farm outbuildings		459	200 482,03	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
460	Farm with residence - with or without secondary structures; with farm outbuildings		460	38 839,45	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
461	Farm with residence - with or without secondary structures; with farm outbuildings		461	40 271,46	0,00	0,00	0,00	2 110,87	0,00	0,00	0,00	21,11	0,00	21,11
462	Farm with residence - with or without secondary structures; with farm outbuildings		462	69 708,04	0,00	0,00	0,00	3 291,52	0,00	0,00	0,00	32,92	0,00	32,92
463	Farm with residence - with or without secondary structures; with farm outbuildings		463	104 672,12	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
464	Farm with residence - with or without secondary structures; with farm outbuildings		464	198 828,65	35 941,14	0,00	0,00	0,00	176,11	0,00	0,00	0,00	0,00	176,11
465	Farm without residence - with secondary structures; with farm outbuildings		465	51 790,41	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
466	Farm with residence - with or without secondary structures; with farm outbuildings		466	51 915,39	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
467	Farm with residence - with or without secondary structures; with farm outbuildings		467	68 701,90	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
468	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed		468	61 736,33	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
469	Farm with residence - with or without secondary structures; with farm outbuildings		469	44 907,02	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
470	Farm with residence - with or without secondary structures; with farm outbuildings		470	19 858,07	0,00	0,00	0,00	3 098,16	0,00	0,00	0,00	30,98	0,00	30,98
471	Farm without residence - with secondary structures; with farm outbuildings		471	87 577,13	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
472	Farm property without any buildings/structures		472	86 612,37	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
473	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed		473	48 102,29	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
474	Farm with residence - with or without secondary structures; with farm outbuildings		474	40 428,90	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
475	Farm with residence - with or without secondary structures; no farm outbuildings		475	53 917,19	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
476	Farm with residence - with or without secondary structures; with farm outbuildings		476	208 146,06	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
477	Farm with residence - with or without secondary structures; with farm outbuildings		477	40 840,22	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
478	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed		478	103 984,81	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
479	Farm with residence - with or without secondary structures; with farm outbuildings		479	38 316,94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
480	Farm with residence - with or without secondary structures; with farm outbuildings		480	64 801,02	47 511,43	0,00	0,00	0,00	0,00	232,81	0,00	0,00	0,00	232,81
481	Farm property without any buildings/structures		481	53 438,97	41 205,21	0,00	0,00	0,00	0,00	201,91	0,00	0,00	0,00	201,91
482	Land owned by a non-farmer improved with a non-farm residence with a portion being farmed		482	104 514,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
483	Farm with residence - with or without secondary structures; no farm outbuildings		483	40 604,31	17 246,93	0,00	0,00	0,00	0,00	84,51	0,00	0,00	0,00	84,51
484	Farm with residence - with or without secondary structures; with farm outbuildings		484	41 308,05	15 289,61	0,00	0,00	0,00	0,00	74,92	0,00	0,00	0,00	74,92
485	Large scale greenhouse operation		485	187 438,31	0,00	0,00	0,00	75 399,71	0,00	0,00	0,00	754,00	0,00	754,00
486	Farm with residence - with or without secondary structures; with farm outbuildings		486	20 216,97	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
487	Farm with a winery		487	237 200,03	160 021,41	0,00	0,00	0,00	0,00	784,10	0,00	0,00	0,00	784,10
488	Vacant residential/commercial/ industrial land owned by a non-farmer with a portion being farmed		488	170 519,26	80 279,57	0,00	0,00	0,00	0,00	393,37	0,00	0,00	0,00	393,37

14 511,27

Appendix D.

3175

Paper Stock/Process Pump



3175

Designed to Handle the Toughest Jobs in the Pulp & Paper and Process Industries

- Capacities to 28,000 GPM (6360 m³/h)
- Heads to 350 feet (107 m)
- Temperatures to 450°F (232° C)
- Pressures to 285 PSIG (1965 kPa)

Design Features

- Back Pull-Out
- Fully Open Impeller
- External Impeller Adjustment
- Renewable Wear Parts
- Maximum Sealing Flexibility
- Heavy Duty Construction
- Maximum Parts Interchangeability

Applications

- **Pulp & Paper** - Paper Stock through 6% Consistency, Black Liquor, Hydropulper and Broke Service, Low NPSH Digester Circulation, Blow Tank to Screens, Primary Screens Rejects, High Density Chlorine Tower to Washer, Flotation Cell Circulation
- **Chemical** - Evaporator and Reboiler Circulation, Slurry Services
- **Petroleum** - Corrosive/Abrasive Crude, Catalyst Slurry, Coke Fines
- **Steel** - Mill Descaling, Waste Treatment, Venturi Scrubber, Electro-Galvanizing Recirculation
- **Food** - Fruit Pulps, Grain Mash and Spent Grains, Evaporator Recirculation, Beet and Cane Sugar, Corn Products
- **General** - Waste Treatment, Air Pollution Abatement, Acid Mine Water, Textile Slurries



Wide Range of Materials

Stocked in Cast Iron and 316 Stainless Steel. Available in any machinable alloy including 317SS, 317LSS, 316LSS, Alloy 20, CD4MCuN, 6-7% moly, Titanium, Hastelloy B and C



A Proven Performer

Since its introduction in 1968, the 3175 has proved itself over and over again. Thousands of installations attest to its remarkable performance even under the severest conditions. And for ease of maintenance, it can't be beat. Customers know they can rely on the 3175 for minimum downtime, increased productivity.



A 3175 installed in a major chemical plant.



Black liquor circulation pump (3175 XL) on spring-loaded baseplate.



Model 3175 handling paper stock



Taking suction from a large stock tank... the 3175 is the preferred pump in the Pulp & Paper Industry



3175's on process service such as multi-effect evaporators.

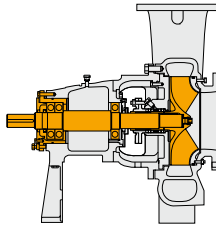


Preventive maintenance is fast and easy on a 3175.

Long Life/Low Maintenance/Reliable Operation

External Impeller Adjustment

Impeller clearance can be easily reset by external adjustment to maintain hydraulic performance. Delivers long time energy savings, while downtime is kept to a minimum.



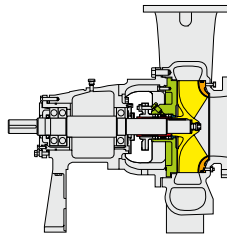
Optional TaperBore™ Seal Chamber

Features an enlarged bore for improved lubrication and cooling of the mechanical seal. The tapered throat keeps solids away from seal faces and from building up in the chamber. Seal life is remarkably extended.



Renewable Wear Parts

Low maintenance costs because all wear parts...suction sideplate, impeller, stuffing box cover, shaft sleeve and throat bushing...are easily replaced.



Fully Open Impeller

Special warped vane, heavy duty open type for paper stock handling. Back pump-out vanes reduce stuffing box pressure, and help prevent solids from entering sealing chamber.



Heavy Duty Shaft

Designed for continuous service under most severe operating conditions—dry end broke, repulper, hydropulper, blowtank. Low deflection at maximum load for long seal and bearing life, extended MTBF.



Standard Labyrinth Oil Seals

Prevent contamination of lubricant for extended bearing life.

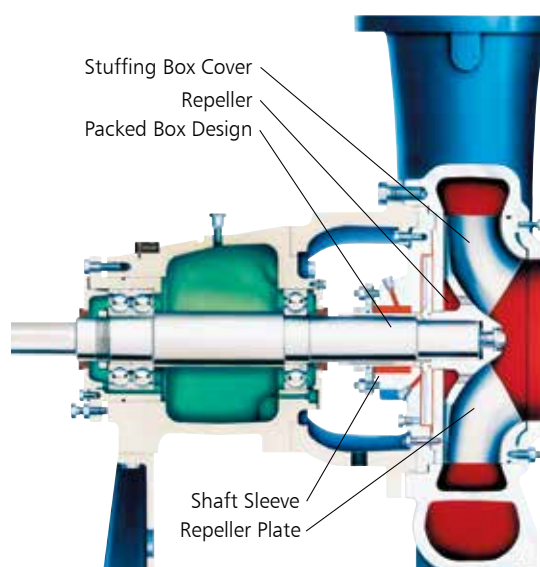


Maximum Sealing Flexibility

Dynamic Seal

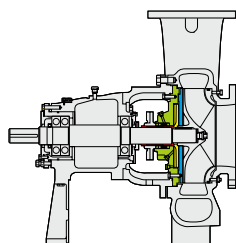
**For elimination of mechanical seal problems;
reduced maintenance**

Goulds Dynamic Seal pumps are designed to handle the tough applications where conventional mechanical seals or packing require outside flush and constant, costly attention. The major advantage is that external seal water is not required, thus eliminating leakage, pumpage contamination, product dilution and problems associated with piping from a remote source.



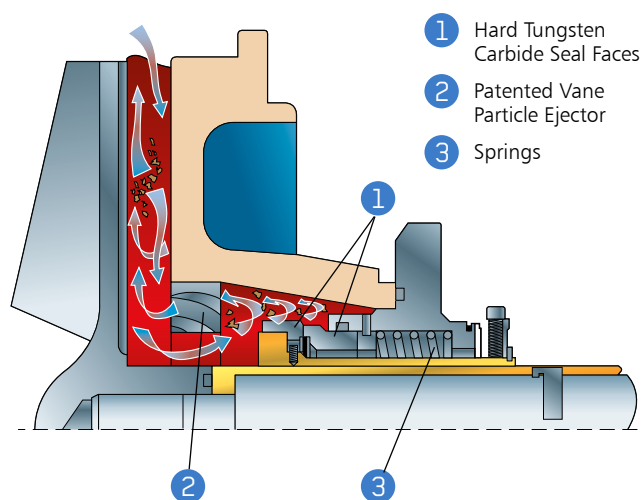
Standard Model 3175 pumps can be fitted with a repeller between the stuffing box and impeller. At startup, the repeller functions like an impeller and pumps liquid from the stuffing box. When the pump is shut down, a conventional static seal prevents pumpage from leaking.

The 3175 is easily field converted to Dynamic Seal. Goulds retrofit kit includes repeller, stuffing box cover, repeller plate, shaft sleeve and choice of static sealing arrangement.



TaperBore™ Seal Chamber

Goulds optional TaperBore™ seal chamber features an enlarged bore for improved lubrication and cooling of the mechanical seal. The design features a tapered throat and a vane particle ejector to keep solids away from seal faces and from building up in the seal chamber. Seal life is remarkably extended.



Goulds TaperBore™ seal chamber and cartridge mechanical seal. A full range of other seal types is available.

Parts List and Materials of Construction

Item No.	Part Name	Materials Description					
		All Iron/CD4(1)	All 316SS	All 317SS	All CD4MCu	DI/CD4	5A Super Duplex
100	Casing	Cast Iron	316SS	317SS	CD4MCu	D.I.	5A Super Duplex
101	Impeller	316SS	316SS	317SS	CD4MCu	316SS	5A Super Duplex
105 ¹	Lantern Ring(2)	Glass Filled Teflon					
106	Stuffing Box Packing	1/2" x 1/2" Non-Asbestos; 1" x 1" Non-Asbestos for XL					
107	Gland, Packed Box	316SS	316SS	317SS	316SS	316SS	5A Super Duplex
108	Frame Adapter	Cast Iron					
109A	Bearing End Cover-Coupling End	Cast Iron					
112A	Ball Bearing Coupling End	Steel					
119A	Bearing End Cover-inboard	Cast Iron					
122	Shaft	AISI 4140					
125	Stuffing Box Throat Bushing	Cast Iron	316SS	317SS	CD4MCu	Cast Iron	5A Super Duplex
126 ²	Shaft Sleeves (Packed Box)	316SS Hard Metal Coated		317SS	316SS HMC	316SS Hard Metal Coated	2507 Super Duplex
134A	Bearing Housing	Cast Iron					
136	Bearing Locknut and Lockwasher	Steel					
168A	Radial Bearing	Steel					
174	Suction Sideplate	Cast iron	316SS	317SS	CD4MCu	Cast Iron	5A Super Duplex
176	Suction Sideplate	Cast iron	316SS	317SS	CD4MCu	Cast Iron	5A Super Duplex
178	Impeller Key	AISI 303					
178J	Repeller Sleeve Key (Dynamic Seal)	AISI 304					
184	Stuffing Box Cover	Cast Iron	316SS	317SS	CD4MCu	D.I.	5A Super Duplex
198	Impeller Screw	316SS					
228	Bearing Frame	Cast Iron					
241	Frame Foot	Cast Iron					
496	O-ring--Bearing Housing	Buna-N					
264	Gasket-Backplate to S.B. Cover (Dynamic Seal)	Aramid Fiber with EPDM Rubber Binder					
265	8.52736E+14	AISI 304					
332A	Labyrinth Oil Seal-Coupling End	Bronze					
333A	Labyrinth Oil Seal-Inboard	Bronze					
351	Gasket--S.B. Cover to Casing	1/16" Non Asbestos					
353	Gland Stud/Nut	AISI 304					
356E	Stud/Nut--Suction sideplate	AISI 303					
360	Gasket-Inboard Bearing End Cover	Vellumoid					
360A	Gasket-Outboard Bearing End Cover	Vellumoid					
360P	Gasket-Sideplate to Casing	1/16" Non Asbestos					
412	O-ring--Shaft Sleeves	Teflon					
412B	O-ring, Impeller Screw	Teflon					
412C	O-ring, Suction Sideplate	Buna-N					
412U	O-ring, Repeller (Dynamic Seal)	PTFE					
494	Cooling Coil (Optional)	Copper/Steel					

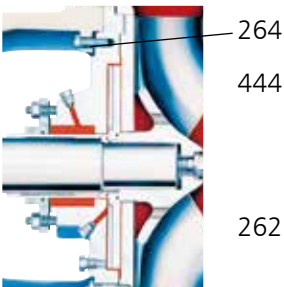
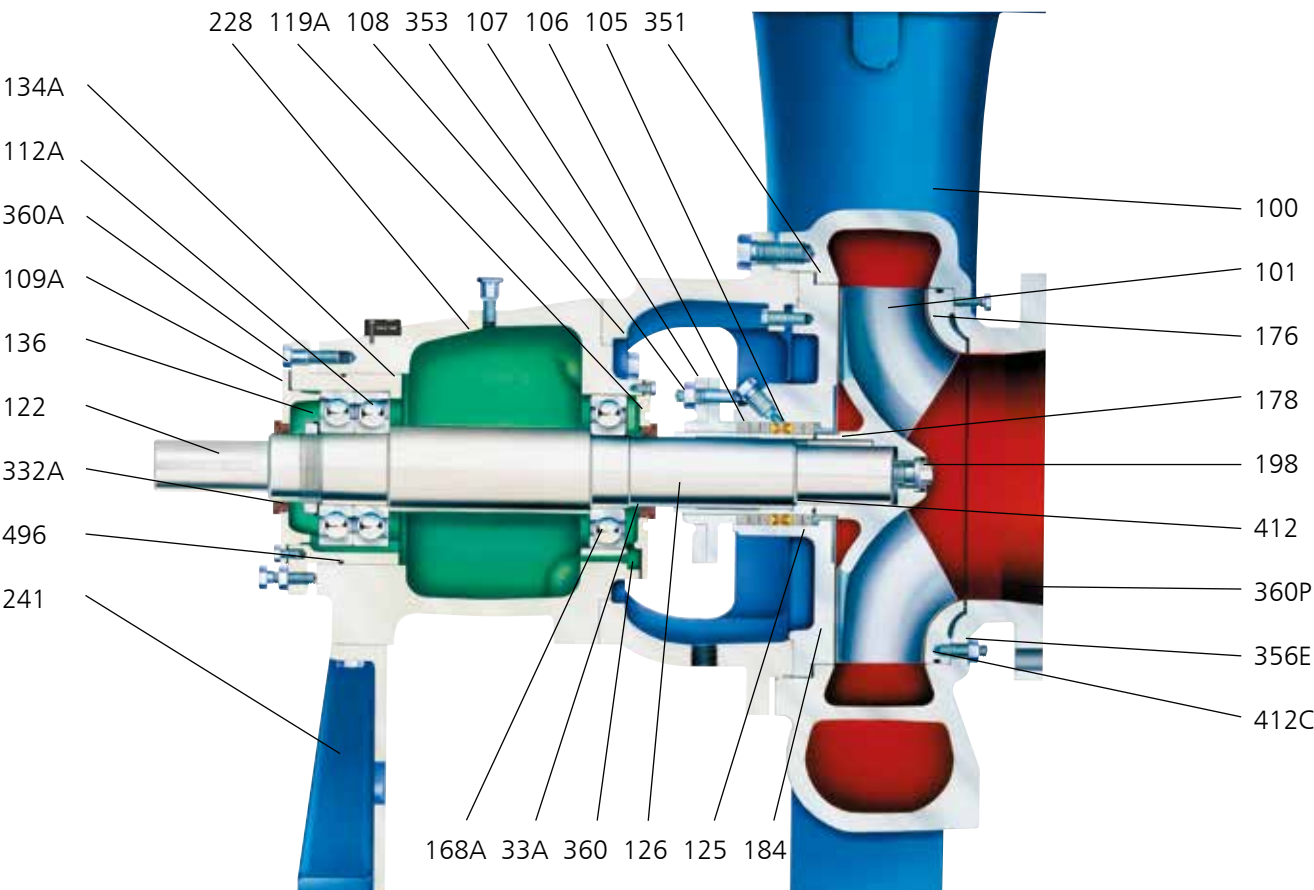
1. Group XL only: Cast Iron for All 316SS trim, 316SS for All 316SS, 317SS for All 317SS, 316SS for All CD4MCu.

2. Standard sleeve for 317SS pumps with packed box is 317SS and is not hard-coated. Standard sleeve for pumps with 2 mechanical seal is 316SS (317SS on all 317SS).

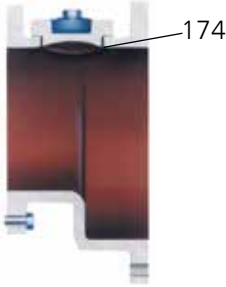
Materials of Construction

Cast Iron	Cast Iron—ASTM A48, Class 20, 25, 30	303SS	303 Stainless Steel—ASTM A582 Type 303
316SS	316 Stainless Steel— (Cast) ASTM A743 Gr CF-8M (Wrought) ASTM A276 Type 316	304SS	304 Stainless Steel—ASTM A276 Type 304
		317SS	317 Stainless Steel—ASTM A743 Gr CG-8M
		CD4MCu	Iron-Chrome-Nickel Alloy—ASTM A743 Gr CD4MCu
		Steel	Carbon Steel—ASTM A322 Gr 4140

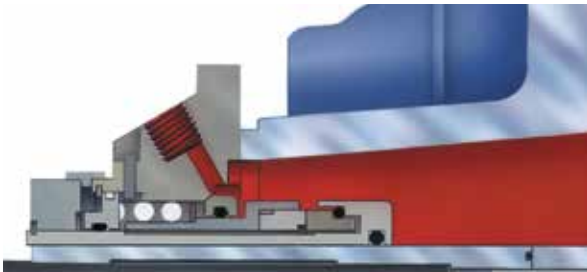
Sectional View



Dynamic Seal Option



Optional Suction Piece



TaperBore™ Seal Chamber and Mechanical Seal Option



Optional High Efficiency Finned Cooler

3175 Paper Stock / Process Pumps

Heavy Duty Design Features for Handling the Toughest Services

LABYRINTH SEALS

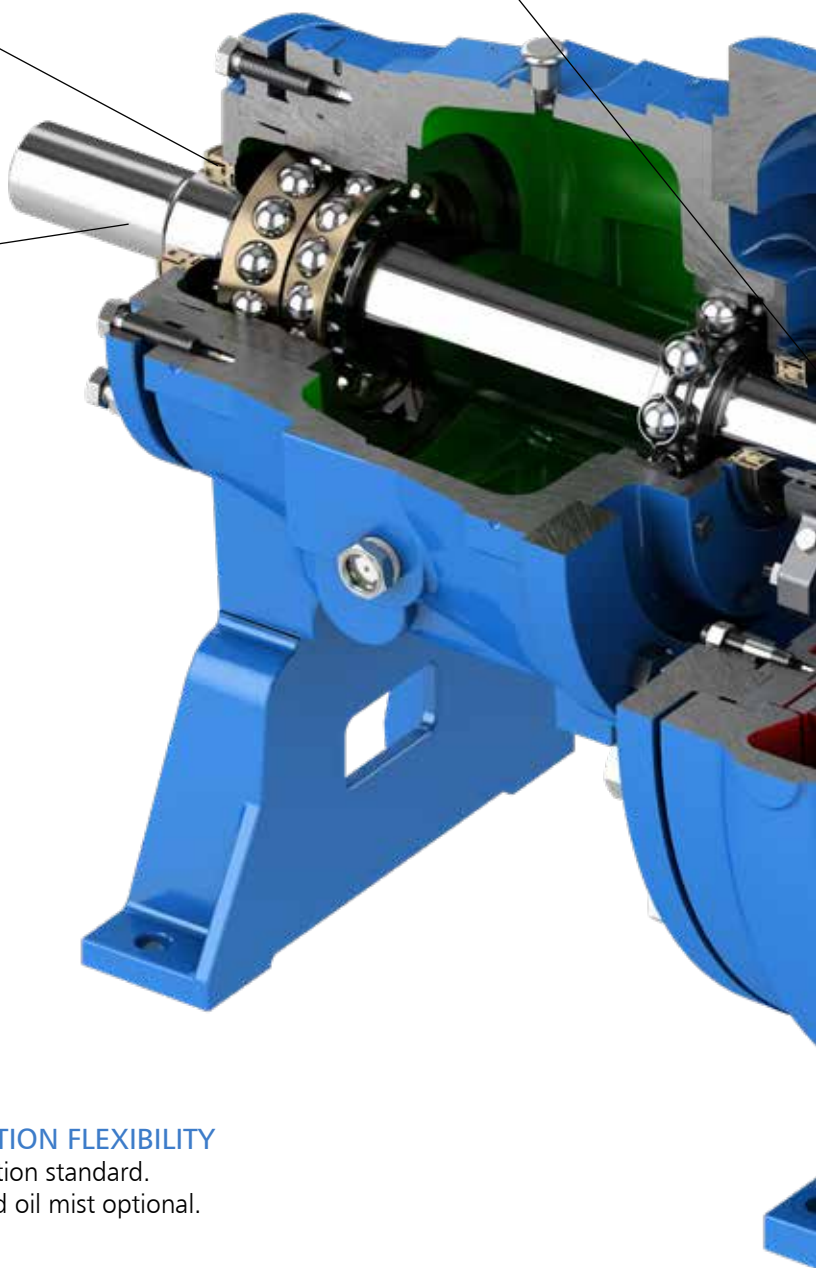
Standard Labyrinth Oil Seals prevent premature bearing failure caused by lubricant contamination and loss of lubricant.

HEAVY DUTY SHAFT

Designed for minimum deflection at maximum load. Dry shaft design—sealed by O-rings at sleeve / impeller hub and impeller bolt.

RENEWABLE SHAFT SLEEVE

Hook-type sleeve is positively driven by impeller key. Free to expand with temperature changes.

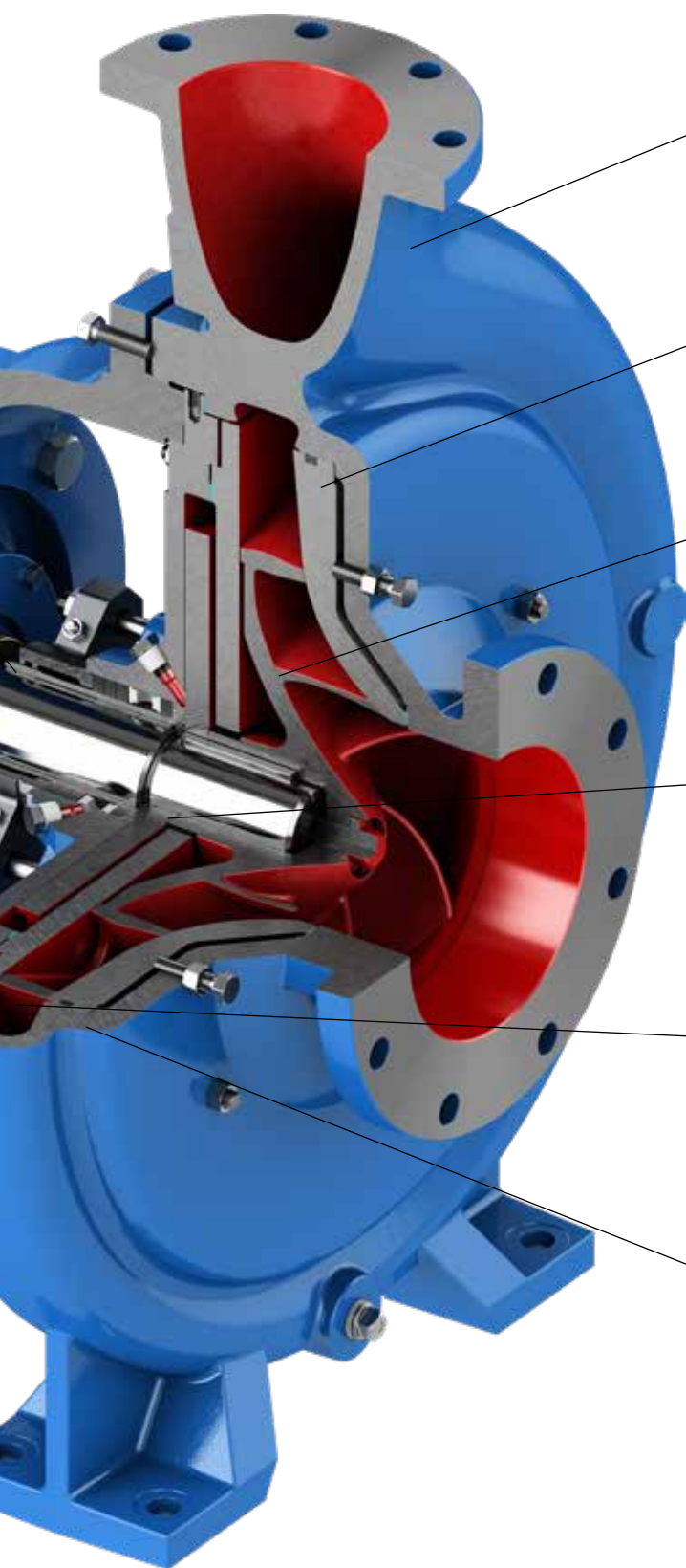


OPTIONAL HIGH EFFICIENCY FINNED COOLER

Requires minimum cooling water; easily cleaned to maintain bearing cooling efficiency. Corrosion resistant materials standard.

LUBRICATION FLEXIBILITY

Oil lubrication standard.
Grease and oil mist optional.



VERTICAL CENTERLINE DISCHARGE

Self-venting design for air handling. Casing provides maximum piping support.

RENEWABLE SIDEPLATE

Heavy suction sideplate minimizes maintenance costs. Positively sealed with O-ring and gasket.

FULLY OPEN IMPELLER

Designed for full range of services. Back pump-out vanes minimize stuffing box pressure, help prevent solids from entering seal chamber.

REPLACEABLE STUFFING BOX BUSHING

Minimizes packing and sleeve maintenance.

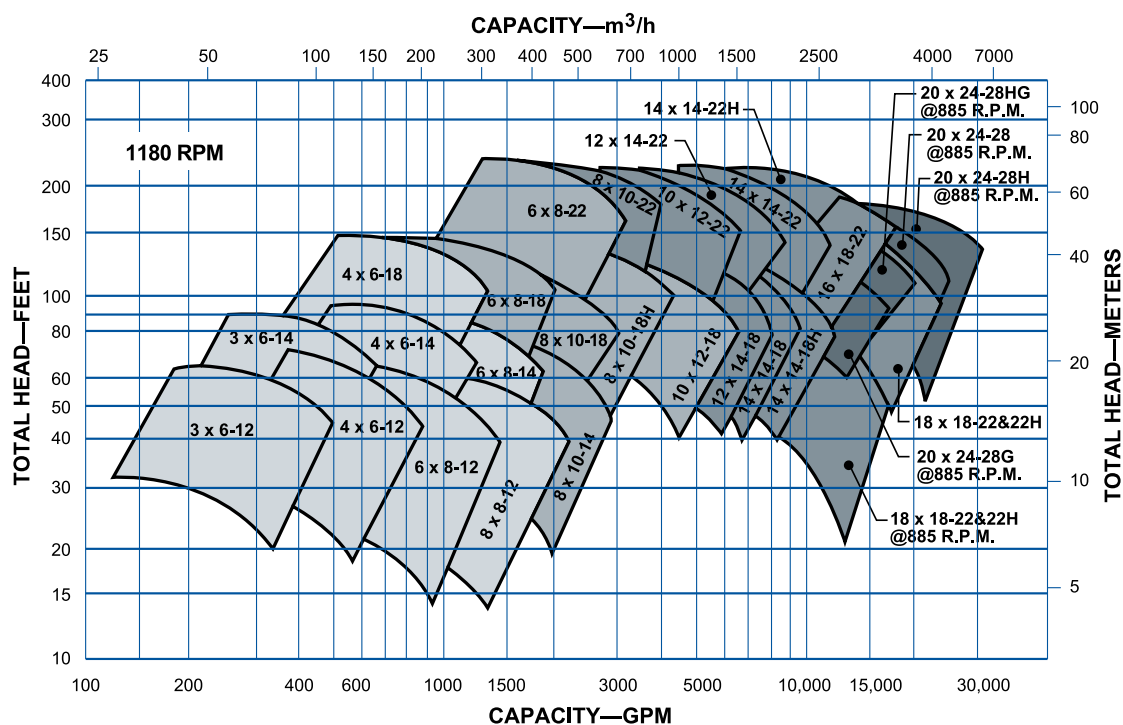
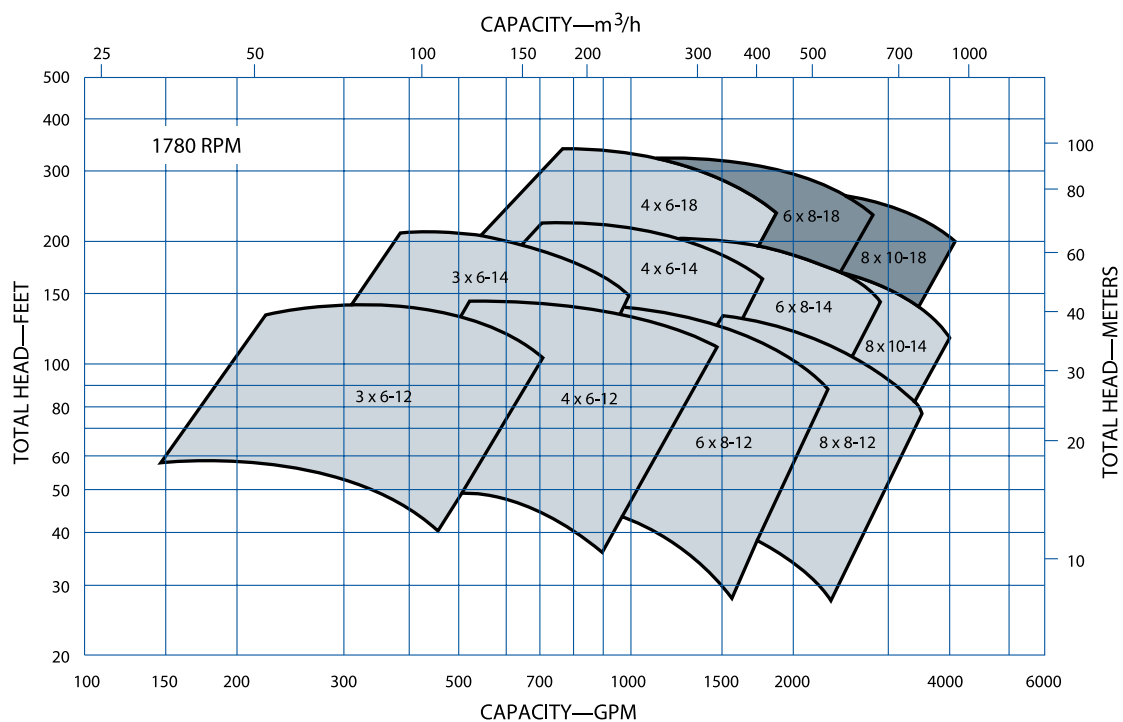
DUAL VOLUTE CASING

Provided on sizes as required to minimize radial unbalance for long packing, mechanical seal and bearing life.

EXTRA THICK WALL SECTIONS

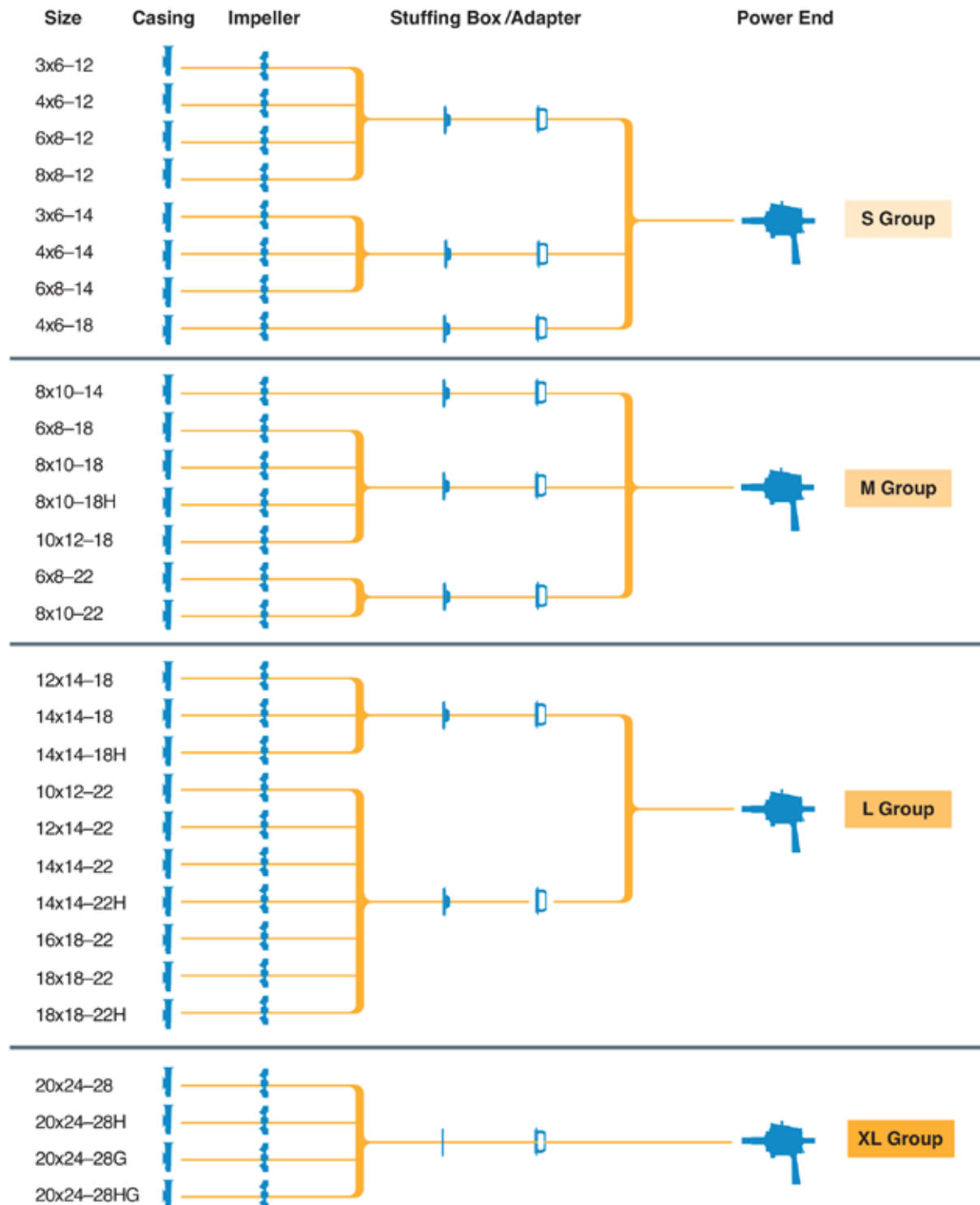
For extended wear life and reduced maintenance.

Hydraulic Coverage

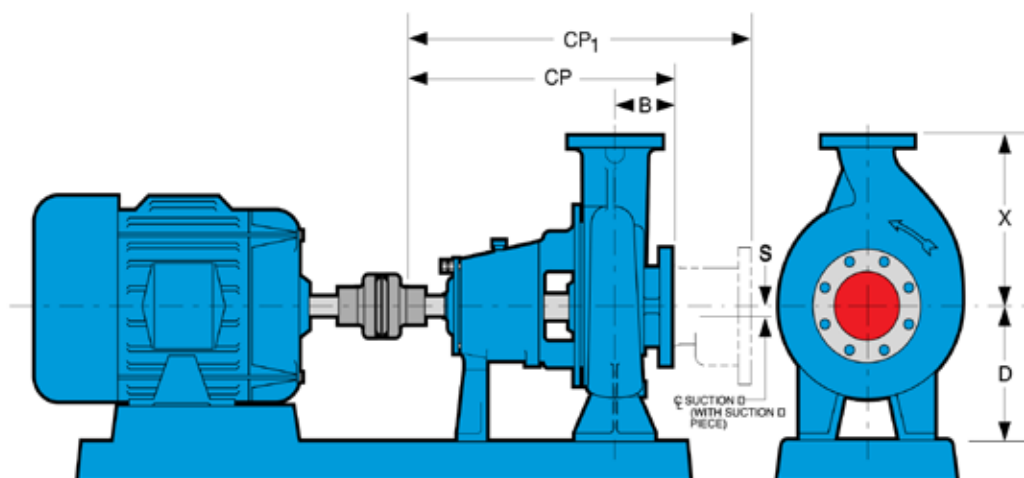


Modular Interchangeability

Minimum Parts Requirements



Dimensions



DIMENSIONS													
Group	Pump Size	Disch. Size	Suct. Size	Suct. Size*	D	X	B	CP	CP ₁	S	Shaft Diameter at Coupling	Bare Pump Weight* Lbs. (kg.)	
S	3x6-12	3	6	8	—	13 (330)	7¼ (184)	39½ (1010)	51 (1295)	1 (25)	1.875 (47.63)	745 (338)	
	4x6-12	4	6	10	12½ (318)	14½ (368)				810 (367)			
	6x8-12	6	8	—	—	16 (406)				2 (51)	1.874 (47.60)	975 (442)	
	8x8-12	8	8	12	14½ (368)	19 (483)	8⅝ (206)	41⅞ (1045)	52⅞ (1330)	1 (25)	1.875 (47.63)	1205 (547)	
	3x6-14	3	6	8	12½ (318)	13 (330)	7¼ (184)	39½ (1010)	51 (1295)			2 (51)	850 (386)
	4x6-14	4	6	10		14½ (368)							925 (420)
	4x6-18	4	6	10		16 (406)							1050 (476)
	6x8-14	6	8	12		16 (406)				1100 (499)			
M	6x8-18	6	8	12	14½ (368)	18 (457)	7¼ (184)	39½ (1010)	51 (1295)	2 (51)	2.375 (60.33) 2.374 (60.30)	1525 (692)	
	6x8-22	6	8	12	17 (432)	21 (533)						1700 (771)	
	8x10-14	8	10	14	14½ (368)	19 (483)						1550 (703)	
	8x10-18	8	10	14	14½ (368)	21 (533)	8⅝ (206)	41⅞ (1045)	53 (1346)			1600 (726)	
	8x10-18H	8	10	14	17 (432)	21 (533)						1725 (782)	
	8x10-22	8	10	14	17 (432)	23 (584)						1800 (816)	
	10x12-18	10	12	16	20 (508)	23 (584)						1900 (862)	
L	10x12-22	10	12	16	20 (508)	25 (635)	8⅝ (206)	41⅞ (1045)	53 (1346)	2 (51)	3.375 (85.73) 3.374 (85.70)	2050 (930)	
	12x14-18	12	14	18	20 (508)	25 (635)						2000 (907)	
	12x14-22	12	14	18	20 (508)	27 (686)						2350 (1066)	
	14x14-18	14	14	20	20 (508)	27 (686)	8⅞ (225)	42½ (1080)	55 (1397)	3 (76)		2125 (964)	
	14x14-18H	14	14	20	22 (559)	30 (762)						2800 (1270)	
	14x14-22	14	14	20	22 (559)	30 (762)						3800 (1724)	
	16x18-22	16	18	—	28 (711)	32 (813)	12¾ (324)	47⅞ (1205)	—	—		4500 (2041)	
	18x18-22	18	18	—	28 (711)	34 (864)	9⅞ (251)	43½ (1105)	—	—		4300 (less suction piece)	
	18x18-22H	18	18	—	28 (711)	34 (864)	16⅞ (422)	50¼ (1276)	—	—			
XL	20x24-28	20	24	—	30 (762)	40 (1016)	17½ (445)	66¾ (1695)	—	—	3.875 (98.43) 3.874 (98.40)	5300 (2404)	
	20x24-28H												
	20x24-28G												
	20x24-28HG												

*With Suction Piece

All dimensions in inches and (mm). Not to be used for construction.

Construction Details

		S Group	M Group	L Group	XL Group
Temperature Limits	Maximum Liquid Temperature—Oil Lubrication Without Cooling	250°F (121°C)			
	Maximum Liquid Temperature—Oil Lubrication with Frame Cooling	350°F (177°C)—Cast Iron 450°F (232°C)—Steel			
	Maximum Liquid Temperature—Grease Lubrication	250°F (121°C)			
Power Limits	HP (kW) per 100 RPM—904L and Alloy 20 Construction	9.52 (7.10)	23.8 (17.8)	63.5 (47.4)	113.6 (84.7)
	HP (kW) per 100 RPM—Constructions other than Alloy 20	17.4 (13.0)	31.9 (23.8)	82.2 (61.3)	129.0 (96.2)
Shaft Diameter	At Impeller	1 7/8 (48)	2 1/4 (70)	3 1/8 (86)	3 7/8 (98)
	Under Shaft Sleeve	2 1/2 (64)	3 1/8 (84)	4 1/8 (109)	5 (127)
	At Coupling	1 7/8 (48)	2 1/8 (60)	3 1/8 (86)	3 7/8 (98)
	Between Bearings	3 1/8 (79)	4 (102)	4 1/8 (124)	6 (152)
Sleeve	O.D. through Stuffing Box	3 (76)	3 1/8 (95)	4 1/8 (121)	5 1/8 (140)
Bearings	Thrust (Coupling End)	SKF 7313 BECBY	SKF 7317 BEGAM	SKF 7222 BECBM	SKF 7326 BECBM
	Radial (Inboard or Pump End)	SKF 6313	SKF 6317	SKF 6222	SKF 6326
	Bearing Span	12 1/8 (311)	11 11/16 (297)	11 1/8 (283)	18 (457)
	Shaft Overhang	10 11/16 (271) to 11 1/2 (301)	11 11/16 (290) to 12 1/8 (319)	11 1/8 (302) to 13 1/8 (344)	19 (483)
Stuffing Box	Bore	4 (102)	4 1/4 (121)	5 1/4 (146)	7 1/2 (191)
	Depth—to Stuffing Box Bushing	3 11/16 (94)			6 3/4 (171)
	Packing Size	1/2 x 1/2 (13 x 13)			1 x 1 (25 x 25)
	Distance from End of Stuffing Box to Nearest Obstruction	3 1/8 (79)		3 1/8 (83)	3 1/8 (95)

All dimensions in inches and (mm). Not to be used for construction.

World Class Service; Value-Added Capabilities

Goulds is much more than a manufacturer and marketer of pumps. Capabilities that extend from project consultation to on-site testing and start-up evaluation are available to every customer. Many specialized services from Goulds are only evident after the sale and installation of the product: parts, repair, training and more.

Research and Development

Goulds continually tests and evaluates every product. The R&D team constantly seeks innovative designs, new materials and system improvements.



Fabrication and Casting

The most advanced foundry and fabrication concepts are utilized to improve quality. We depend on only the best foundries to produce castings from iron to Hastelloy including a wide range of high alloys.



Repair and Overhaul

Goulds PRO (Pump Repair and Overhaul) Services® Centers repair all types of rotating equipment. Each facility also has special diagnostic equipment to facilitate preventive maintenance. Let the nearest PRO Services® Center demonstrate repair as an economical alternative to replacement.



Field Service

A staff of highly specialized installation, training and commissioning engineers is available to insure each projects' successful completion and start-up.

Training

Goulds Pumps provides a comprehensive training program that includes in-depth product education as well as operations and maintenance courses. Each session is designed as a continuous learning opportunity, supporting customers worldwide in building their knowledge and expertise.

Parts Availability

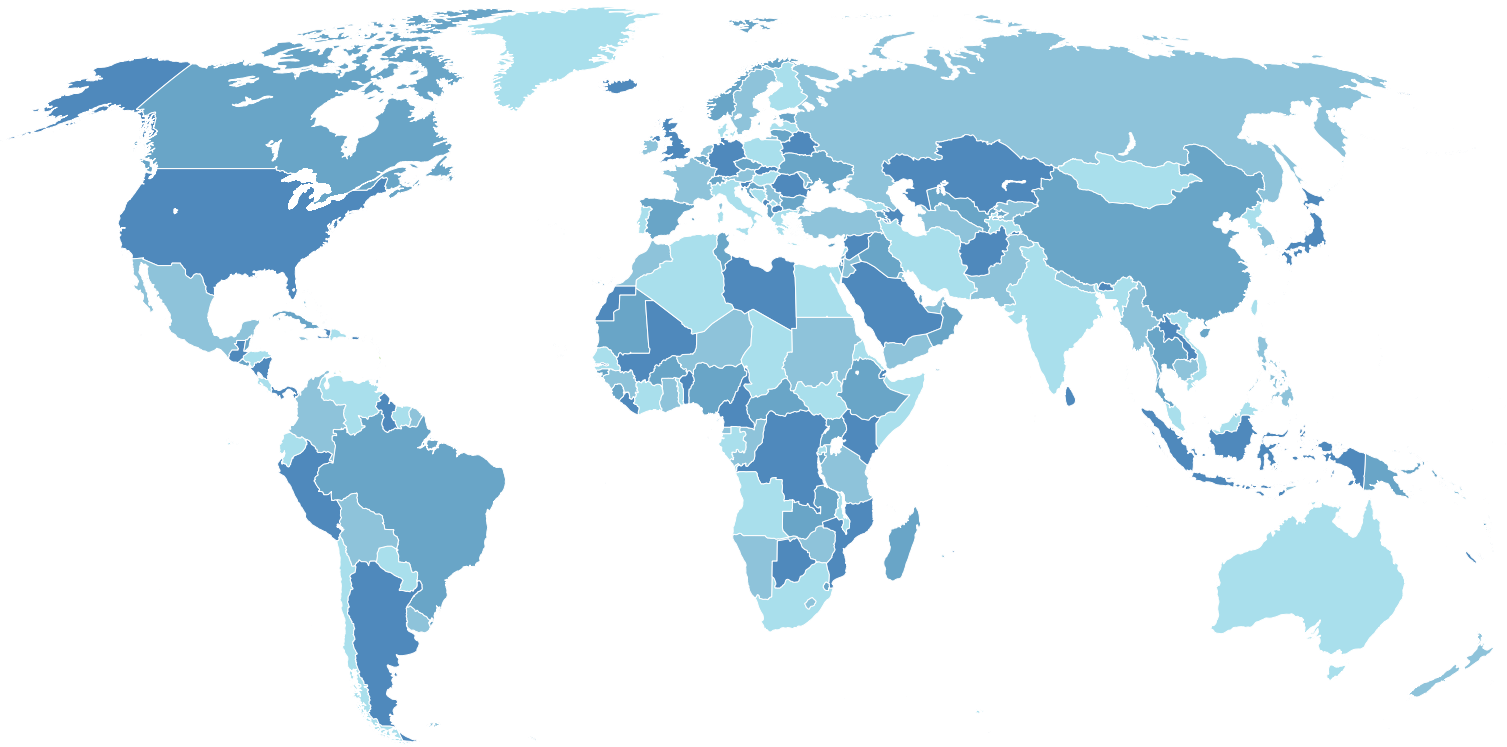
Goulds Pumps Distribution Centers are strategically located worldwide, and are committed to the ready availability of repair parts.

Service and Support

In addition to direct sales offices around the world, over 200 authorized Goulds representatives and distributors are totally committed to meeting customers' requirements.

Notes

Notes



Visit www.ittproservices.com & www.gouldspumps.com to
find nearest service, sales, and manufacturing locations



— An ITT Brand

240 Fall Street

Seneca Falls, NY 13148

Phone: 315.568.2811

Fax: 315.568.2418

www.gouldspumps.com

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RUDI KOVACKO & ASSOC US

Niagara-on-the-Lake

PROPOSAL: 00726 - DEE ROAD STATION

Item Name: ITEM 001 - 2026 BUDGET (Base Offer)

Rudi Kovacko
Rudi Kovacko & Assoc. Inc.
1197 Fewster Drive, Unit A
Mississauga, Ontario L4W
1A2
Ph: 905-238-0308
Fx: 905-238-6327
E-Mail: rudi@rudikovacko.com

February 5, 2026

MODEL: 3175 L SIZE: 14x14-22/4V QTY: 1

Operating Conditions

SERVICE

LIQUID Water, Rated Temp. 80.0 deg F, SP.GR 1.000, Viscosity
1.000 cp, Rated/Max. suction pressure 0.0 / 0.0 psi g

CAPACITY Rated 5,000.0 gpm

HEAD 108.0 (ft)

AMBIENT TEMP

Performance at 885 RPM per HI 14.6 1B

PUBLISHED EFFY 83.0% (CDS)

RATED EFFY 83.0%

RATED POWER 163.8 hp (Run out 198.6 hp)

NPSHR 7.2 ft

DISCH PRESSURE (R) 46.9 psi g (57.6 psi g @ Shut off) based on 0.0 psi g rated
suction pressure

PERF. CURVE 2043-3 (Rotation CW viewed from coupling end)

SHUT OFF HEAD 133.1 ft

MIN. FLOW Continuous Stable: 2,817.2 gpm Hydraulic: 2,817.2 gpm
Thermal: N/A

PRICE in CAD	
Pump Unit	Incl
Driver	Incl
Boxing	
Testing	
Freight	
Total 1 Unit	173,569.90

Materials

CONSTRUCTION All iron / CD4
CASING Cast iron (max. casing pressure @ rated temperature: 150.0 psi g)
ST.BOX COVER CD4MCuN
IMPELLER CD4MCuN - Open (22.4375 in rated, max=22.5000 in, min=17.5000 in)
SHAFT MATERIAL SAE 4140
SHAFT SLEEVE CD4
LUBRICATION Flood oil
ST.BOX TYPE Standard non cooled
GLAND 316SS Plain
BEARINGS 222M OR EQUAL (Inboard) / 7222P.D.B OR EQUAL (Outboard)
COUPLING Rexnord - Omega Rex Elastomer- ES-70 (standard orange element)-S.F. 1.00
COUPLING PROPERTIES 1.0 Coupling service factor, AGMA Class 1 Clearance Fit
COUPLING GUARD Steel
BASEPLATE Fabricated steel drip lip

Sealing Method

PACKING PackRyt BLR

Flanges



125# flat face

St.box-Seal chamber features

Second lantern ring connection

Frame Features

Labyrinth Bearing Protection Devices

Magnetic Plug

Shaft guard (Carbon Steel)

Shaft guard - safety orange

Assembly and Testing

Casing & Cover - Standard hydro test

Impeller balanced to ISO G6.3

Painting

Goulds Blue standard painting

Noise Level Data

Maximum predicted sound pressures level pump only in Decibels (db) Re 0.0002 microbars measured 3ft horizontally and 5ft from the floor per QCP 580

Noise Level	31.5	63	125	250	500	1k	2k	4k	8k	A
Pump	83.0	86.0	86.0	83.5	84.5	85.0	82.5	79.0	74.0	89.5

Driver : Electric motor Manufacturer : WEG

FURNISHED BY	Pump Mfg	MOUNTED BY	Pump Mfg
RATING	200.0 hp (149.1 KW)	ENCLOSURE	TEFC - Premium Efficiency
PHASE/FREQ/VOLTS	3/60 Hz/575	SPEED	900 RPM
INSULATION/SF	F/1.15	FRAME	449T

Weights and Measurements

TOTAL NET UNIT WEIGHT / VOLUME	6,237.0 lb / 152.2 ft³
TOTAL GROSS UNIT WEIGHT / GROSS VOLUME	7,559.0 lb / 264.4 ft³
TOTAL GROSS UNIT DIMENSIONS (X,Y,Z)	123.5in / 51.74in / 71.5in

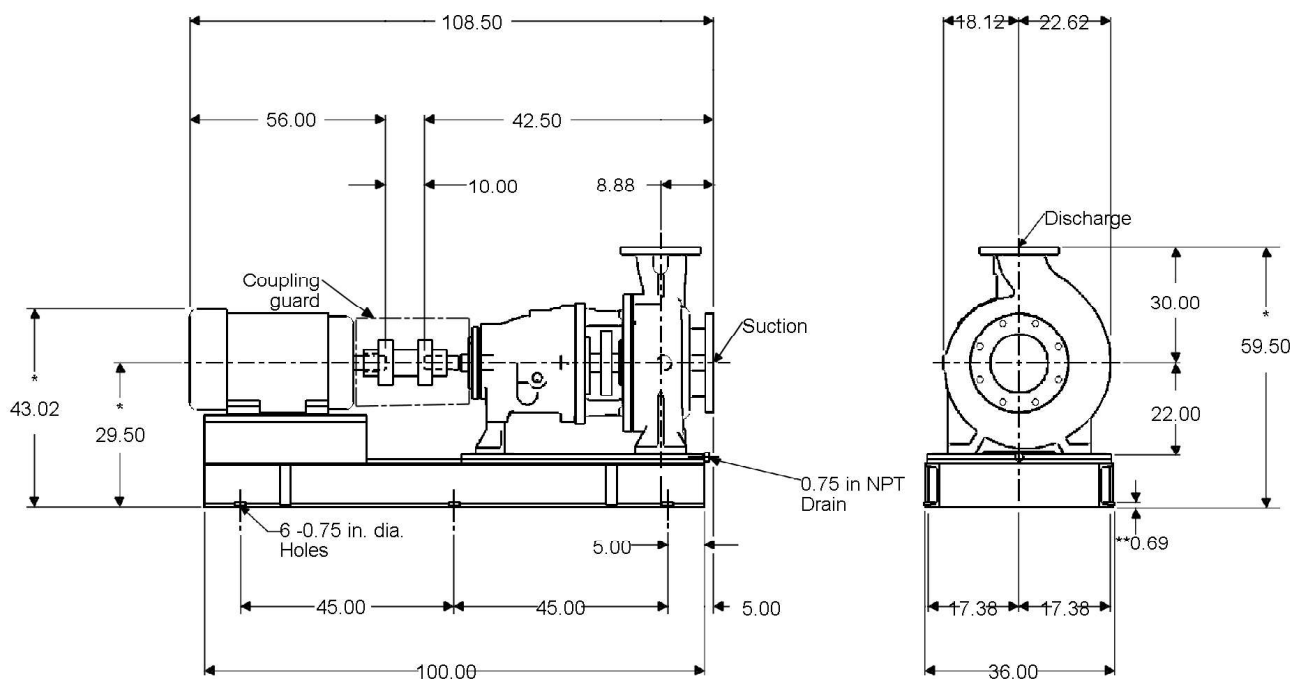
Program Version 1.76.0.0

This proposal reflects the intended scope from the customer specifications supplied at the time of quotation. Additional specifications, requirements and scope presented at time of award or during order execution outside the original bid scope request, is subject to a change order with a potential cost and lead-time impact. ITT reserves the right to present engineering charges for more than two revision cycles on submittal drawings, provided these two revision cycles cover the intent of the specifications. ITT requires customer to provide all drawing comments applicable to the specification within the first submission return.

Our offer does not include specific review and incorporation of any Statutory or Regulatory Requirements and the offer is limited to the requirements of the design specifications. Should any Statutory or Regulatory requirements need to be reviewed and incorporated then the Customer is responsible to identify those and provide copies for review and revision of our offer.

Our quotation is offered in accordance with our comments and exceptions identified in our proposal. The pricing quoted herein will remain valid for 30 business days from the time of quotation. In the event that this validity should expire, please contact your ITT sales representative to confirm pricing validity prior to order placement.

Please note: Due to current market volatility caused by governmental assessment of tariffs and duties we reserve the right to add a tariff surcharge related up to the date of shipment of any product(s) ordered from ITT in the foreseeable future. Pricing will reflect changes on an ongoing basis.



Pump Specification

SUCT.FLANGE SIZE	14"	DRILLING	ANSI 125#	FACING	FF	FINISH	SMOOTH
DISCH.FLANGE SIZE	14"	DRILLING	ANSI 125#	FACING	FF	FINISH	SMOOTH
PUMP ROTATION (LOOKING AT PUMP FROM MOTOR)	CW						
TYPE OF LUBRICATION	FLOOD OIL					COOLED	NO
TYPE OF STUFFING BOX	STANDARD NON COOLED					COOLED	NO
TYPE OF SEALING	PACKING						

Weights and Measurements

PUMP	2,385.0 lb
MOTOR/CPLG	2,550.0/102.0 lb
BASEPLATE	1,200.0 lb
TOTAL	6,237.0 lb
GR.VOLUME w/BOX	264.4 ft ³
GR.WEIGHT w/BOX	7,559.0 lb

Motor Specification

MOTOR BY	PUMP MFG	MOUNT BY	PUMP MFG	MFG.	WEG
FRAME	449T	POWER	200.0 hp	RPM	900
PHASE	3	FREQUENCY	60 HZ	VOLTS	575
INSULATION	F	S.F.	1.15		
ENCLOSURE	TEFC - PREMIUM EFFICIENCY				

Notes and References

- MTR DIMENSIONS ARE APPROXIMATE
- INSTALL FOUNDATION BOLTS IN PIPE SLEEVES
- ALLOW FROM 0.75 to 1.50in. FOR GROUTING. SEE INSTRUCTION BOOK FOR DETAILS.
- * Tolerance is +0-.013
- ** Foundation bolt grip thickness

Auxiliary Specification

COUPLING BY	PUMP MFG	CPLG TYPE	REXNORD OMEGA REX ELASTOMER- ES-70 (STANDARD ORANGE)
CPL GUARD BY	PUMP MFG	CPLG GUARD MATL	STEEL
BASEPLATE	FABRICATED STEEL DRIP LIP		
PACKING	PACKRYT BLR		

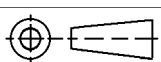
FOR PUMP TAPPED OPENINGS REFER TO DWG.:
T00917-NOTL / ITEM 001 - 2026 BUDGET

DRAWING IS FOR REFERENCE ONLY.
NOT CERTIFIED FOR CONSTRUCTION UNLESS SIGNED.

Customer: Niagara-on-the-Lake
End User: Niagara-on-the-Lake
Customer PO No:
Item/Equip. No: ITEM 001 - 2026 BUDGET
Serial No:

Copyright 2025
ITT Corp

DRAWING NO 00917-NOTL/ITEM 001 - 2026 BUDGET



All dimensions are in inches.
Drawing is not to scale
Weights (lbs) are approximate

Model: 3175**Size: 14x14-22****Group: L****60Hz****RPM: 885****Stages: 1**

Customer: Niagara-on-the-Lake

End User: Niagara-on-the-Lake

Customer PO No:

Item/Equip. No: ITEM 001 - 2026 BUDGET (Base Offer)

Project No:

Service:

Job/Inquiry No:

Issued By: Bruce Currell

Quotation No: 00917-NOTL

Certified By:

Date: 02/05/2026

Revision: 0

Operating Conditions

Liquid: Water

Temp.: 80.0 deg F

S.G./Visc.: 1.000/1.000 cp

Flow: 5,000.0 gpm

TDH: 108.0 ft

NPSHa:

Solid size:

% Susp. Solids
(by wtg):

Published Efficiency:

Rated Pump Efficiency:

Rated Total Power:

Non-Overloading Power:

Imp. Dia. First 1 Stg(s):

NPSHr:

Shut off Head:

Vapor Press:

Pump Performance

83.0 %

83.0 %

163.8 hp

198.6 hp

22.4375 in

7.2 ft

133.1 ft

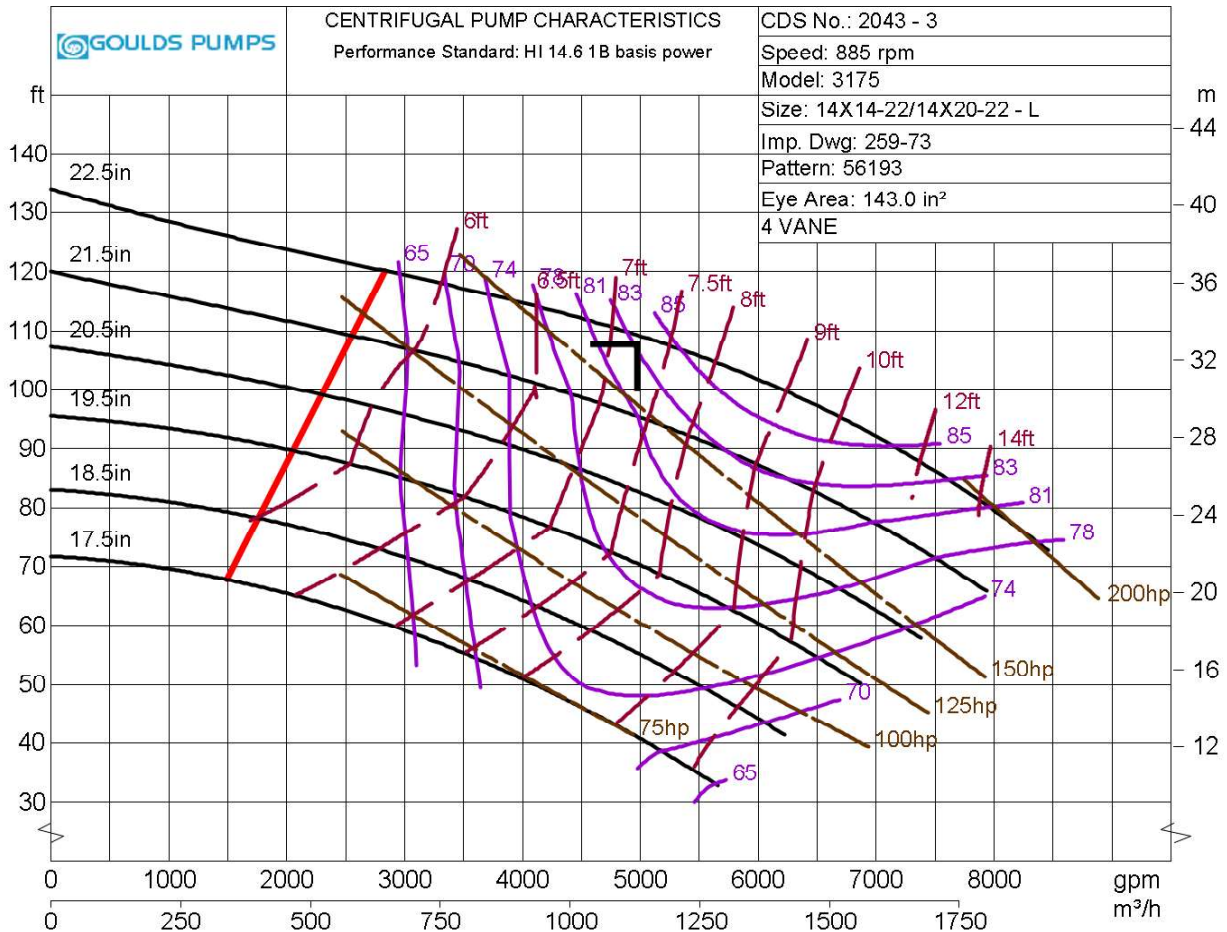
Suction Specific Speed: 13,465 gpm(US) ft

Min. Hydraulic Flow: 2,817.2 gpm

Min. Thermal Flow: N/A

Max. Solids Size: 2.1250 in

- Notes:**
1. Power and efficiency losses are not reflected on the curve below.
 2. Curve shown is at ambient temperature conditions.



Sales Person: Cody Veach

Phone: 270-685-6934

Email: cveach@hendrickcorp.com

Area Rep: IDA

Phone: 269-925-7552

Email: Ed@IDASales.com

Quotation Date: 2/13/2026

Expiration Date: 3/5/2026

Payment Terms: TBD at Credit Approval

(Credit Cards accepted with a 4% processing fee)

Shipping Terms: EX Works-Owensboro

Ship Via:

Sold To: Aecom - Kitchener

50 Sportsworld Crossing Drive

Suite 290

Kitchener, ON N2P0A4

Canada

Contact:

Phone:

Email:

Ship To: Aecom - Kitchener

50 Sportsworld Crossing Drive

Suite 290

Kitchener, ON N2P0A4

Canada

Project: NOTL Irrigation - Budgetary

QUOTE DETAIL				
			ALL PRICES IN US Dollars (USD)	
Line	Part	Rev	Quantity	Each
1	WIT		1.00	\$237,000.00
	42" OD x 158" OAL			\$237,000.00
	DRAWING LEAD TIME: 2 weeks			
	SHIPPING LEAD TIME: see note below from Drawing Approval			
	Screen Type: T - Intake			
	Flow Required: 8,000 gpm			
	Screen Diameter: 42"			
	Overall Screen Length (approx.): 158"			
	Wire Size: 69v			
	Slot size: .04"			
	Debris Deflector: none			
	Outlet size: 30"			
	Airburst Connection Size: 4"			
	Material Type: 90/10 CUNI			
	Flow Criteria: max slot velocity			
	Flow Velocity: .5 fps			
	Design Pressure (FT): 23			
	Pressure Drop Thru Assembly: < 12" of water			
	Approx. Wt.: 2,834 lbs			
	-Shipment lead time is currently 12 weeks+ but could vary depending on material availability. A firm lead time will be provided when submittals are approved and material is ordered.			
Line	Part	Rev	Quantity	Each
2	Airburst		1.00	\$86,615.00
	660 Gallon Receiver			\$86,615.00
	SHIPPING LEAD TIME: 16-18 weeks			
	Compressor:			
	One - 20hp reciprocating compressor, Splash lubricated, 460/3/60 ODP motor, Low Oil Switch, Aftercooler, 76.1 scfm Will fill receiver (660 Gallon) (30-150) psi in 10 minutes			
	Receivers:			
	One - 660 gallon 200psi ASME rated horizontal receiver with Powder coat finish, Pressure switch, Pressure gauge, Safety valve and Auto drain.			
	Valves:			
	One - 4" 150# Lug style butterfly valve DI body, SS Disc & stem, BUNA seat with Pneumatic vane style Fail Close Actuator w/ Limit Switch, Visual cone and Direct mount solenoid w/manual override.			
	Control Panel:			

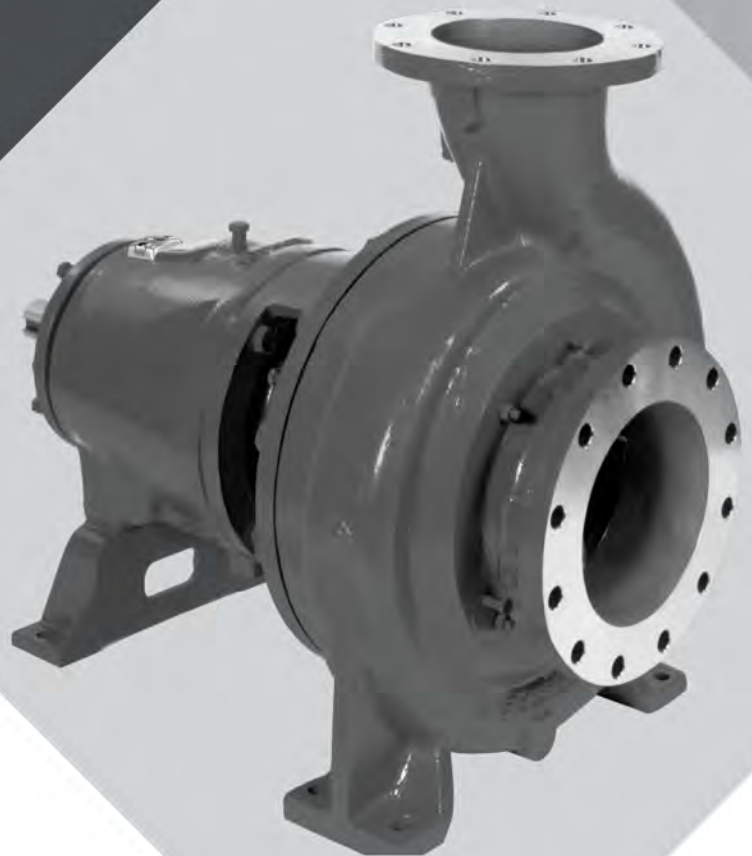
Terms and Conditions

- 1. Acceptances**
This quotation is effective for twenty days from the date on page one of this quotation (unless otherwise noted thereon) and Buyer's written acceptance must be received at Seller's office address appearing on the front of this quotation and no other attempted acceptance, oral or written, will be binding on Seller. The buyer shall be responsible for all changes in quoted freight rates including changes in freight rates after acceptance of the order until the order is shipped. In the event material prices stated in this quotation increase greater than 5% prior to the material being received by Hendrick, the price shall be adjusted to reflect the amount of the increase. Acceptance of this quotation is expressly limited to these Terms and Conditions and the rights of the Buyer and Seller shall be determined exclusively hereby. If the Buyer uses its pre-printed purchase order or other form for acceptance of this quotation, it is expressly understood and agreed that the Terms and Conditions herein shall prevail over any additional, conflicting or different provisions set forth in such Buyer's form, and the issuance of any such purchase order or form by the Buyer shall be deemed to constitute Buyer's assent and agreement to these Terms and Conditions and, in particular, the revisions of this paragraph 3.
- 2. Quotations on Buyer's Specifications**
If this quotation is made pursuant to specifications, drawings or blueprints furnished by the Buyer and Buyer changes or alters said specifications, drawings or blueprints, Seller reserves the right, at its sole discretion, to void this quotation and resubmit a new quotation which shall be considered an offer to sell. Buyer is obligated at all times to notify Seller of any change in its specifications, drawings or blueprints. Buyer acknowledges that Seller has not verified or checked any of the information supplied on the Buyer's drawings or specifications and is not responsible for any errors or omissions contained in that information.
- 3. Buyer's Creditworthiness**
If, in the judgment of the Seller, the financial condition of the Buyer at any time does not justify initiation or continuance of production or shipment on the terms specified on page one of two of this quotation, Seller may require full or partial payment of the price stated on page one of two of this quotation.
- 4. Delays**
Seller shall not be liable for loss or damage due to delay in manufacture or delivery resulting from any cause beyond Seller's reasonable control, including but not limited to compliance with any regulations, orders or instructions of any Federal, State or municipal government or any department or agency thereof, acts of God, acts or omission of the Buyer, acts of any civil or military authority, fires, strikes, factory shutdowns or alternations, embargoes, war, riot, delays in transportation or inability due to causes beyond the Seller's reasonable control to obtain necessary labor, manufacturing facilities or materials from Seller's usual sources, and any delays resulting from any such cause extends the delivery date accordingly. IN NO EVENT SHALL THE SELLER BE LIABLE FOR SPECIAL OR CONSEQUENTIAL DAMAGES FOR ANY DELAY FOR ANY CAUSE.
- 5. Patent Infringement**
Buyer shall save the Seller harmless from all loss, damage or liability, including attorney's fees, arising out of the manufacture by Seller for the Buyer of any patented device or a part thereof or on account of the use of such articles by Buyer, the patents for which Seller does not own or control.
- 6. Warranty- Disclaimer-Limitation of Remedy and Damages**
THIS OFFER TO SELL IS BEING MADE ON THE EXPRESS UNDERSTANDING THAT THERE ARE NO EXPRESS OR IMPLIED WARRANTIES OTHER THAN THOSE CONTAINED IN THIS PARAGRAPH 8 AND THAT THERE ARE NO IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Seller warrants the goods sold against defects in material and workmanship for a period of thirty (30) days after the Buyer's receipt of shipment. THE OBLIGATION OF THE SELLER UNDER THIS WARRANTY SHALL BE LIMITED, AT SELLER'S OPTION, TO REPAIRING OR REWORKING F.O.B. SELLER'S PLANT, OR ALLOWING CREDIT ON ANY GOODS WHICH MAY PROVE TO BE DEFECTIVE, PROVIDED THAT BUYER GIVES SELLER PROMPT NOTICE OF THE DEFECT OR DEFECTS. IT IS EXPRESSLY AGREED BY BUYER THAT THIS REMEDY OF REWORKING, REPLACEMENT OR CREDIT AT SELLER'S OPTION, IS THE EXCLUSIVE REMEDY UNDER THIS CONTRACT. Goods returned without the Seller's written permission will not be accepted for credit and will be returned to Buyer F.O.B. Seller's plant. Expenses incurred by Buyer in repairing, reworking or replacing any defective product will not be allowed except by written permission of Seller. Written permission shall include all cost of the work performed and permission must be obtained from the seller prior to any work performed otherwise those expenses are the sole responsibility of the buyer and the warranty becomes null and void. It is the responsibility of the buyer to provide final approval of the drawings or blueprints supplied by the seller verifying the information meets the specifications. Specifications must be provided in writing the seller shall not be responsible for errors or omissions of verbally generated specifications or changes in specifications. IN THE EVENT OF A BREACH OF THIS CONTRACT BY SELLER, THE BUYER IS LIMITED TO THE REMEDIES SET FORTH IN THIS PARAGRAPH AND SHALL NOT BE ENTITLED TO AND HEREBY WAIVES ANY CLAIM FOR CONSEQUENTIAL DAMAGES.
- 7. Customer's Material**
Material furnished by the Buyer for use in the manufacture of the goods shall be shipped to the Seller freight pre-paid and all risk of loss or damage to the Buyer's material shall remain with the Buyer.
- 8. Cancellation, Changes or Alterations**
The Buyer's order, as specified in this quotation, cannot be cancelled or altered nor can deferred deliveries of goods completed or in process be extended beyond the original specified delivery dates, except with the Seller's express written consent and upon terms acceptable to Seller which will indemnify Seller against any loss. In the event an order is cancelled the buyer will be responsible for all charges which may include materials, engineering fees, drafting services, O&M's, processing fees, outside processing, administrative fees, cancellation charges, and any other charges incurred by the seller related to the buyers order.
- 9. Seller's Remedies as Cumulative**
The rights and remedies of the Seller hereunder shall be cumulative and the exercise of any one of them shall not be exclusive of any other right or remedy provided by this contract or allowed by law.
- 10. Assignment of Contract**
Buyer may not assign this contract without the prior written consent of Seller.
- 11. Entire Agreement**
This contract contains the entire agreement between the Seller and the Buyer and is not subject to modification except by written agreement signed by both Buyer and Seller.
- 12. Law Governing and Forum Selection**
The Buyer and Seller agree that this contract is a contract for the sale of goods and disputes hereunder shall be governed by the Uniform Commercial Code and other laws of the Commonwealth of Kentucky and case law there under, and all claims for damages and/or breach of this contract shall be filed in the Circuit Court for Daviess County, Kentucky.
- 13. Sales Tax:** Quotations do not include sales tax.



Installation, Operation and Maintenance Instructions

3175



ITT

Table of Contents

1 Introduction and Safety	3
1.1 Introduction.....	3
1.1.1 Requesting other information	3
1.2 Safety	3
1.2.1 Safety terminology and symbols	4
1.2.2 Environmental safety.....	5
1.2.3 User safety	6
1.3 Product warranty	8
1.4 Ex Considerations and Intended Use.....	8
2 Transportation and Storage.....	11
2.1 Transportation and Storage.....	11
2.1.1 Inspect the delivery	11
2.1.2 Transportation guidelines	11
2.1.3 Storage guidelines	13
3 Product Description	15
3.1 Description of Units	15
3.2 General description i-ALERT® Equipment Condition Monitor.....	15
3.3 Nameplate information	16
4 Installation.....	20
4.1 Pre-installation.....	20
4.2 Location.....	20
4.3 Install Close-Coupled and Vertical Pumps	20
4.4 Install Horizontal Pumps.....	21
4.5 Pump-to-driver alignment	23
4.5.1 General Alignment Procedures	23
4.6 General Piping.....	27
4.7 General Suction Piping.....	28
4.8 Suction Piping Design for Large Pumps.....	31
4.8.1 Installations with Pump Above Source of Supply - Suction Lift.....	32
4.8.2 Installations with Pump Below Source of Supply - Suction Head or Flooded Suction	32
4.9 Discharge Piping	33
4.10 Connection of Piping	33
4.11 Rotation	33
4.12 Connection of Coupling	33
4.13 Install the coupling guard	34
5 Commissioning, Startup, Operation, and Shutdown	39
5.1 Preparation for startup.....	39
5.2 Pump Bearings.....	40
5.3 Driver Bearing and Coupling	42
5.4 Stuffing Box Packing	42
5.5 Remove Packing	43
5.6 Mechanical Seals	44
5.7 Install the shaft guard - if provided	45
5.8 Connection of Sealing Liquid or Grease Lubricator (Packed Box).....	45

5.9	Connection of Cooling Water Piping	45
5.10	Connection of Drain Piping.....	46
5.11	Connection of Equalizing Piping.....	46
5.12	Impeller Adjustment.....	47
5.13	Check for Free Turning	47
5.14	Regulation of Cooling and Flushing Liquids	47
5.15	Priming	47
5.16	Start the pump.....	52
5.17	Activate the i-ALERT® Health Monitor	52
5.18	i-ALERT® Equipment Health Monitor.....	53
5.19	Pump operation precautions	53
5.20	Initial Inspection After Starting.....	54
5.21	Final Alignment.....	55
5.22	Doweling.....	55
5.23	Stuffing Box Operation	56
5.24	Operating at Reduced Capacities	56
5.25	Operating at Reduced Head.....	57
5.26	Operating with Surge Conditions in Line	57
5.27	Operating under Freezing Conditions	57
5.28	Deactivate the i-ALERT® Equipment Health Monitor.....	57
5.29	Reset the i-ALERT® Health Monitor	58
6	Maintenance.....	59
6.1	Bearing Maintenance	59
6.1.1	Bearing Temperatures.....	59
6.1.2	Bearing Inspection	59
6.1.3	Clean the Bearings.....	59
6.1.4	Bearing Removal.....	60
6.1.5	Install the Ball Bearings.....	61
6.2	Lubricate the Pump	62
6.3	Impeller Clearance Adjustment	64
6.4	Disassembly precautions	66
6.5	Disassemble the Pump	67
6.6	Guidelines for i-ALERT® Equipment Health Monitor disposal	72
6.7	Inspection and Overhaul	72
6.8	Reassemble the Pump	74
6.9	Set the Mechanical Seals.....	79
6.10	Stuffing Box.....	80
6.11	Shaft guard installation (if provided)	80
6.11.1	Install the shaft guard	80
7	Troubleshooting	82
7.1	Troubleshooting Checklist	82
7.2	i-ALERT® Equipment Health Monitor troubleshooting	84
8	Parts List and Cross-Sectionals	85
8.1	Spare Parts	85
8.2	Instructions for Ordering Spare Parts.....	86
8.3	Parts List	86
8.4	Parts list and interchangeability chart.....	91
8.5	Pump Selection Chart	97

1 Introduction and Safety

1.1 Introduction

Purpose of this manual

The purpose of this manual is to provide necessary information for:

- Installation
- Operation
- Maintenance



CAUTION:

Failure to observe the instructions contained in this manual could result in personal injury and/or property damage, and may void the warranty. Read this manual carefully before installing and using the product.

NOTICE:

Save this manual for future reference and keep it readily available.

1.1.1 Requesting other information

Special versions can be supplied with supplementary instruction leaflets. See the sales contract for any modifications or special version characteristics. For instructions, situations, or events that are not considered in this manual or in the sales documents, please contact the nearest ITT representative.

Always specify the exact product type and serial number when requesting technical information or spare parts.

1.2 Safety



WARNING:

- Risk of serious personal injury. Applying heat to impellers, propellers, or their retaining devices can cause trapped liquid to rapidly expand and result in a violent explosion. This manual clearly identifies accepted methods for disassembling units. These methods must be adhered to. Never apply heat to aid in their removal unless explicitly stated in this manual.
- The operator must be aware of the pumpage and take appropriate safety precautions to prevent physical injury.
- Risk of serious injury or death. If any pressure-containing device is over-pressurized, it can explode, rupture, or discharge its contents. It is critical to take all necessary measures to avoid over-pressurization.
- Risk of death, serious personal injury, and property damage. Installing, operating, or maintaining the unit using any method not prescribed in this manual is prohibited. Prohibited methods include any modification to the equipment or use of parts not provided by ITT. If there is any uncertainty regarding the appropriate use of the equipment, please contact an ITT representative before proceeding.

- If the pump or motor is damaged or leaking, electric shock, fire, explosion, liberation of toxic fumes, physical harm, or environmental damage may result. Do not operate the unit until the problem has been corrected or repaired.
- Risk of serious personal injury or property damage. Dry running may cause rotating parts within the pump to seize to non-moving parts. Do not run dry.
- Risk of death, serious personal injury, and property damage. Heat and pressure buildup can cause explosion, rupture, and discharge of pumpage. Never operate the pump with suction and/or discharge valves closed.
- Running a pump without safety devices exposes operators to risk of serious personal injury or death. Never operate a unit unless appropriate safety devices (guards, etc.) are properly installed. See specific information about safety devices in other sections of this manual.

**CAUTION:**

- Risk of injury and/or property damage. Operating a pump in an inappropriate application can cause over pressurization, overheating, and/or unstable operation. Do not change the service application without the approval of an authorized ITT representative.

**WARNING:**

This product contains Carbon Black a chemical known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov

1.2.1 Safety terminology and symbols

About safety messages

It is extremely important that you read, understand, and follow the safety messages and regulations carefully before handling the product. They are published to help prevent these hazards:

- Personal accidents and health problems
- Damage to the product
- Product malfunction

Hazard levels

Hazard level		Indication
	DANGER:	A hazardous situation which, if not avoided, will result in death or serious injury
	WARNING:	A hazardous situation which, if not avoided, could result in death or serious injury
	CAUTION:	A hazardous situation which, if not avoided, could result in minor or moderate injury
	NOTICE:	• A potential situation which, if not avoided, could result in undesirable conditions • A practice not related to personal injury

Hazard categories

Hazard categories can either fall under hazard levels or let specific symbols replace the ordinary hazard level symbols.

Electrical hazards are indicated by the following specific symbol:



ELECTRICAL HAZARD:

These are examples of other categories that can occur. They fall under the ordinary hazard levels and may use complementing symbols:

- Crush hazard
- Cutting hazard
- Arc flash hazard

1.2.1.1 The Ex symbol

The Ex symbol indicates safety regulations for Ex-approved products when used in atmospheres that are potentially explosive or flammable.



1.2.2 Environmental safety

The work area

Always keep the station clean to avoid and/or discover emissions.

Waste and emissions regulations

Observe these safety regulations regarding waste and emissions:

- Appropriately dispose of all waste.
- Handle and dispose of the processed liquid in compliance with applicable environmental regulations.
- Clean up all spills in accordance with safety and environmental procedures.
- Report all environmental emissions to the appropriate authorities.



WARNING:

If the product has been contaminated in any way, such as from toxic chemicals or nuclear radiation, do NOT send the product to ITT until it has been properly decontaminated and advise ITT of these conditions before returning.

Electrical installation

For electrical installation recycling requirements, consult your local electric utility.

1.2.2.1 Recycling guidelines

Always follow local laws and regulations regarding recycling.

1.2.3 User safety

General safety rules

These safety rules apply:

- Always keep the work area clean.
- Pay attention to the risks presented by gas and vapors in the work area.
- Avoid all electrical dangers. Pay attention to the risks of electric shock or arc flash hazards.
- Always bear in mind the risk of drowning, electrical accidents, and burn injuries.

Safety equipment

Use safety equipment according to the company regulations. Use this safety equipment within the work area:

- Hardhat
- Safety goggles, preferably with side shields
- Protective shoes
- Protective gloves
- Gas mask
- Hearing protection
- First-aid kit
- Safety devices

Electrical connections

Electrical connections must be made by certified electricians in compliance with all international, national, state, and local regulations. For more information about requirements, see sections dealing specifically with electrical connections.

Noise



WARNING:

Sound pressure levels may exceed 80 dbA in operating process plants. Clear visual warnings or other indicators should be available to those entering an area with unsafe noise levels. Personnel should wear appropriate hearing protection when working on or around any equipment, including pumps. Consider limiting personnel's exposure time to noise or, where possible, enclosing equipment to reduce noise. Local law may provide specific guidance regarding exposure of personnel to noise and when noise exposure reduction is required.

Temperature



WARNING:

Equipment and piping surfaces may exceed 130°F (54°C) in operating process plants. Clear visual warnings or other indicators should alert personnel to surfaces that may reach a potentially unsafe temperature. Do not touch hot surfaces. Allow pumps operating at a high temperature to cool sufficiently before performing maintenance. If touching a hot surface cannot be avoided, personnel should wear appropriate gloves, clothing, and other protective gear as necessary. Local law may provide specific guidance regarding exposure of personnel to unsafe temperatures.

1.2.3.1 Precautions before work

Observe these safety precautions before you work with the product or are in connection with the product:

- Provide a suitable barrier around the work area, for example, a guard rail.
- Make sure that all safety guards are in place and secure.
- Make sure that you have a clear path of retreat.
- Make sure that the product cannot roll or fall over and injure people or damage property.
- Make sure that the lifting equipment is in good condition.
- Use a lifting harness, a safety line, and a breathing device as required.
- Allow all system and pump components to cool before you handle them.
- Make sure that the product has been thoroughly cleaned.
- Disconnect and lock out power before you service the pump.
- Check the explosion risk before you weld or use electric hand tools.

1.2.3.2 Precautions during work

Observe these safety precautions when you work with the product or are in connection with the product:



CAUTION:

Failure to observe the instructions contained in this manual could result in personal injury and/or property damage, and may void the warranty. Read this manual carefully before installing and using the product.

- Never work alone.
- Always wear protective clothing and hand protection.
- Stay clear of suspended loads.
- Always lift the product by its lifting device.
- Beware of the risk of a sudden start if the product is used with an automatic level control.
- Beware of the starting jerk, which can be powerful.
- Rinse the components in water after you disassemble the pump.
- Do not exceed the maximum working pressure of the pump.
- Do not open any vent or drain valve or remove any plugs while the system is pressurized. Make sure that the pump is isolated from the system and that pressure is relieved before you disassemble the pump, remove plugs, or disconnect piping.
- Never operate a pump without a properly installed coupling guard.

1.2.3.3 Hazardous liquids

The product is designed for use in liquids that can be hazardous to your health. Observe these rules when you work with the product:

- Make sure that all personnel who work with biologically hazardous liquids are vaccinated against diseases to which they may be exposed.
- Observe strict personal cleanliness.
- A small amount of liquid will be present in certain areas like the seal chamber.

1.2.3.4 Wash the skin and eyes

1. Follow these procedures for chemicals or hazardous fluids that have come into contact with your eyes or your skin:

Condition	Action
Chemicals or hazardous fluids in eyes	1. Hold your eyelids apart forcibly with your fingers. 2. Rinse the eyes with eyewash or running water for at least 15 minutes. 3. Seek medical attention.
Chemicals or hazardous fluids on skin	1. Remove contaminated clothing. 2. Wash the skin with soap and water for at least 1 minute. 3. Seek medical attention, if necessary.

1.3 Product warranty

Coverage

ITT undertakes to remedy faults in products from ITT under these conditions:

- The faults are due to defects in design, materials, or workmanship.
- The faults are reported to an ITT representative within the warranty period.
- The product is used only under the conditions described in this manual.
- The monitoring equipment incorporated in the product is correctly connected and in use.
- All service and repair work is done by ITT-authorized personnel.
- Genuine ITT parts are used.
- Only Ex-approved spare parts and accessories authorized by ITT are used in Ex-approved products.

Limitations

The warranty does not cover faults caused by these situations:

- Deficient maintenance
- Improper installation
- Modifications or changes to the product and installation made without consulting ITT
- Incorrectly executed repair work
- Normal wear and tear

ITT assumes no liability for these situations:

- Bodily injuries
- Material damages
- Economic losses

Warranty claim

ITT products are high-quality products with expected reliable operation and long life. However, should the need arise for a warranty claim, then contact your ITT representative.



1.4 Ex Considerations and Intended Use

Special care must be taken in potentially explosive environments to ensure that the equipment is properly maintained. This includes but is not limited to:



Follow these special handling instructions if you have an Ex-approved unit.

Personnel requirements

These are the personnel requirements for Ex-approved products in potentially explosive atmospheres:

- All work on the product must be carried out by certified electricians and ITT-authorized mechanics. Special rules apply to installations in explosive atmospheres.
- All users must know about the risks of electric current and the chemical and physical characteristics of the gas, the vapor, or both present in hazardous areas.
- Any maintenance for Ex-approved products must conform to international and national standards (for example, EN 60079-17).

ITT disclaims all responsibility for work done by untrained and unauthorized personnel.

Product and product handling requirements

These are the product and product handling requirements for Ex-approved products in potentially explosive atmospheres:

- Only use the product in accordance with the approved motor data.
- The Ex-approved product must never run dry during normal operation. Dry running during service and inspection is only permitted outside the classified area.
- Before you start work on the product, make sure that the product and the control panel are isolated from the power supply and the control circuit, so they cannot be energized.
- Do not open the product while it is energized or in an explosive gas atmosphere.
- Make sure that thermal contacts are connected to a protection circuit according to the approval classification of the product, and that they are in use.
- Intrinsically safe circuits are normally required for the automatic level-control system by the level regulator if mounted in zone 0.
- The yield stress of fasteners must be in accordance with the approval drawing and the product specification.
- Do not modify the equipment without approval from an authorized ITT representative.
- Only use parts that are provided by an authorized ITT representative.

Description of Ex-Directives

The Ex-directives are a specification enforced in Europe and the United Kingdom for electrical and non-electrical equipment installed in those locations. Ex-directives deal with the control of potentially explosive atmospheres and the standards of equipment and protective systems used within these atmospheres. The relevance of the Ex-requirements is not limited to Europe or the UK. You can apply these guidelines to equipment installed in any potentially explosive atmosphere.

Guidelines for compliance

Compliance is fulfilled only when you operate the unit within its intended use. Do not change the conditions of the service without the approval of an ITT representative. When you install or maintain explosion proof products, always comply with the directive and applicable standards (for example, IEC/EN 60079-14).

1. Monitoring the pump frame liquid end temperature.
2. Maintaining proper bearing lubrication.

3. Ensuring that the pump is operated in the intended hydraulic range.

The Ex conformance is only applicable when the pump unit is operated within its intended use. Operating, installing or maintaining the pump unit in any way that is not covered in the Instruction, Operation, and Maintenance manual (IOM) can cause serious personal injury or damage to the equipment. This includes any modification to the equipment or use of parts not provided by ITT Goulds Pumps. If there is any question regarding the intended use of the equipment, please contact an ITT Goulds representative before proceeding.

Current IOMs are available at <https://www.gouldspumps.com/en-US/Tools-and-Resources/Literature/IOMs/> or from your local ITT Goulds Pumps Sales representative.

All pumping unit (pump, seal, coupling, motor and pump accessories) certified for use in an Ex classified environment, are identified by an Ex tag secured to the pump or the baseplate on which it is mounted. A typical tag would look like this:

If applicable, your pump may have either a CE Ex (ATEX) tag or UKCA Ex tag affixed to the pump. See the Safety section for a description of the symbols and codes. Typical nameplate only shown below, the actual area classification may be different.

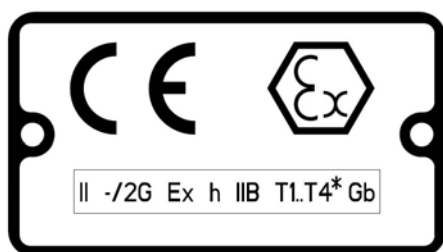


Figure 1: Typical Ex nameplate



Figure 2: Typical UKCA Ex nameplate

Table 1: Temperature class definitions

Code	Maximum permissible surface temperature in °C °F	Maximum permissible liquid temperature in °C °F
T1	440 824	372 700
T2	290 554	267 513
T3	195 383	172 342
T4	130 266	107 225
T5	Option not available	Option not available
T6	Option not available	Option not available

* Maximum liquid temperature may be limited by the pump model and order specific options. [Table 1: Temperature class definitions on page 10](#) is for the purpose of determining T'x' code for Ex applications with liquid temperatures exceeding 107°C | 225°F.

The code classification marked on the equipment must be in accordance with the specified area where the equipment will be installed. If it is not, do not operate the equipment and contact your ITT Goulds Pumps sales representative before proceeding.

ISO 80079-37:2016 Section 5.7

Recommended bearing replacement interval (based on L10 life) = 17,500 hours of operation.

2 Transportation and Storage

2.1 Transportation and Storage

2.1.1 Inspect the delivery

2.1.1.1 Inspect the package

1. Inspect the package for damaged or missing items upon delivery.
2. Note any damaged or missing items on the receipt and freight bill.
3. File a claim with the shipping company if anything is out of order.
If the product has been picked up at a distributor, make a claim directly to the distributor.

2.1.1.2 Inspect the unit

1. Remove packing materials from the product.
Dispose of all packing materials in accordance with local regulations.
2. Inspect the product to determine if any parts have been damaged or are missing.
3. If applicable, unfasten the product by removing any screws, bolts, or straps.
For your personal safety, be careful when you handle nails and straps.
4. Contact your sales representative if anything is out of order.

2.1.2 Transportation guidelines

2.1.2.1 Pump handling



WARNING:

Dropping, rolling or tipping units, or applying other shock loads, can cause property damage and/or personal injury. Ensure that the unit is properly supported and secure during lifting and handling.



CAUTION:

Risk of injury or equipment damage from use of inadequate lifting devices. Ensure lifting devices (such as chains, straps, forklifts, cranes, etc.) are rated to sufficient capacity.

2.1.2.2 Lifting methods



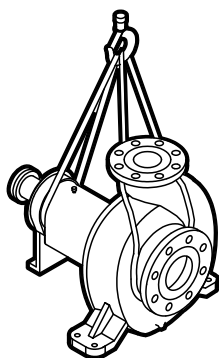
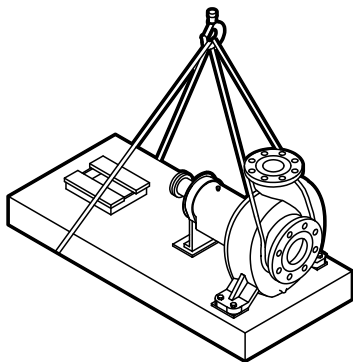
WARNING:

- Risk of serious personal injury or equipment damage. Proper lifting practices are critical to safe transport of heavy equipment. Ensure that practices used are in compliance with all applicable regulations and standards.
- Safe lifting points are specifically identified in this manual. It is critical to lift the equipment only at these points. Integral lifting eyes or eye bolts on pump and motor components are intended for use in lifting the individual components only.

- Lifting and handling heavy equipment poses a crush hazard. Use caution during lifting and handling and wear appropriate Personal Protective Equipment (PPE, such as steel-toed shoes, gloves, etc.) at all times. Seek assistance if necessary.

Table 2: Methods

Pump type	Lifting method
Bare pump without lifting handles	Use a suitable sling attached properly to solid points like the casing, the flanges, or the frames.
A bare pump with lifting handles	Lift the pump by the handles.
A base-mounted pump	Use slings under the pump casing and the drive unit, or under the base rails.
A base-mounted pump with baseplate lifting lugs	Use slings through the baseplate lifting lugs.

Examples**Figure 3: Example of a proper lifting method****Figure 4: Example of a proper lifting method****NOTICE:**

Do not use this method to lift a Polyshield ANSI Combo with the pump and motor mounted. These items are not designed to handle the heavy weight of the Polyshield system. Doing so may result in equipment damage.

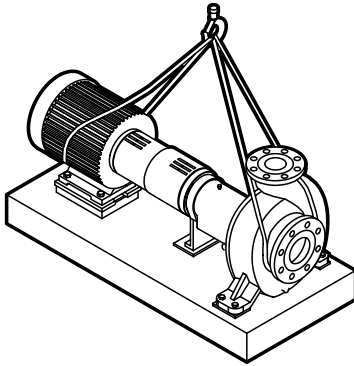


Figure 5: Example of a proper lifting method

NOTICE:

Do not use this method to lift a Polyshield ANSI Combo with the pump and motor mounted. These items are not designed to handle the heavy weight of the Polyshield system. Doing so may result in equipment damage.

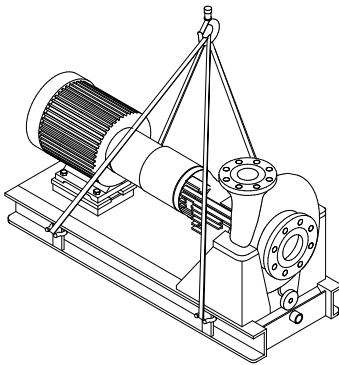


Figure 6: Example of a proper lifting method

NOTICE:

When lifting a unit for which a strap cannot be secured at the suction flange, secure the strap through the frame/frame adapter. Securing at the frame adapter will prevent slipping of the strap and possible equipment damage.

2.1.3 Storage guidelines

2.1.3.1 Pump storage requirements

Storage requirements depend on the amount of time that you store the unit. The normal packaging is designed only to protect the unit during shipping.

Length of time in storage	Storage requirements
Upon receipt/short-term (less than six months)	• Store in a covered and dry location. • Store the unit free from dirt and vibrations.
Long-term (more than six months)	• Store in a covered and dry location. • Store the unit free from heat, dirt, and vibrations.

Length of time in storage	Storage requirements
	• Rotate the shaft by hand several times at least every three months.

NOTICE:

Risk of damage to the mechanical seal or shaft sleeve on units supplied with cartridge mechanical seals. Make sure to install and tighten the centering clips and loosen the set screws in the seal locking ring.

Treat bearing and machined surfaces so that they are well preserved. Refer to drive unit and coupling manufacturers for their long-term storage procedures.

You can purchase long-term storage treatment with the initial unit order or you can purchase it and apply it after the units are already in the field. Contact your local ITT sales representative.

2.1.3.2 Frostproofing

Table 3: Situations when the pump is or is not frostproof

Situation	Condition
Operating	The pump is frostproof.
Immersed in a liquid	The pump is frostproof.
Lifted out of a liquid into a temperature below freezing	The impeller might freeze.

3 Product Description

3.1 Description of Units

**WARNING:**

Use of equipment unsuitable for the environment can pose risks of ignition and/or explosion. Ensure the pump driver and all other auxiliary components meet the required area classification at the site. If they are not compatible, do not operate the equipment and contact an ITT representative before proceeding.

Reference is made to several different types of pumps in the following text. To enable the reader to associate these terms to his particular unit, photographs of typical units with an identifying description are shown below.



Figure 7: Close Coupled

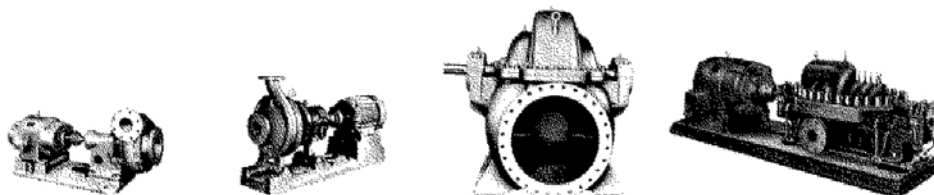


Figure 8: Horizontal



Figure 9: Vertical

3.2 General description i-ALERT® Equipment Condition Monitor

Description

The i-ALERT® Equipment Condition Monitor is a compact, battery-operated monitoring device that continuously measures the vibration and temperature of the pump power end. The i-ALERT® sensor uses blinking red LEDs and wireless notification to alert the pump operator when the pump exceeds vibration and temperature limits. This allows the pump operator to make changes to the process or the pump before a catastrophic failure occurs. The Condition Monitor is also equipped with a single green LED to indicate when it is operational and has sufficient battery life. (i-ALERT® Bluetooth Equipment Condition Monitor option available. The i-ALERT® monitor allows customers to identify potential problems before

they become costly failures. It tracks vibration, temperature and run-time hours and wirelessly syncs the data with a smart phone or tablet the i-ALERT® mobile app. More information available on

More information available on <http://www.ittproservices.com/aftermarket-products/monitoring/i-alert2/i-ALERT2.com>

Current IOMs are available at <http://www.gouldspumps.com/en-us/tools> - and - resources/literature/IOMs, <http://i-alert.com> or your local ITT Goulds Pumps Sales Rep.

Alarm mode

The condition monitor enters alarm mode when either vibration or temperature limits are exceeded over two consecutive readings within a ten minute period. Alarm mode is indicated with two red flashing LEDs within two second intervals.

Temperature and vibration limits

Variable	Limit
Temperature	91°C 195°F
Vibration	100% increase over the baseline level

Battery life

The i-ALERT®2 Condition Monitor battery is not replaceable. You must replace the entire unit once the battery runs out of power.

The battery life is not covered as part of the standard pump warranty.

This table shows the average condition monitor battery life under normal and alarm-mode operating conditions.

Condition monitor operational state	Battery life
Normal operating and environmental conditions	Three to five years
Alarm mode	One year

3.3 Nameplate information

Important information for ordering

Every pump has nameplates that provide information about the pump. The nameplates are located on the casing and the bearing frame.

When you order spare parts, identify this pump information:

- Model
- Size
- Serial number
- Item numbers of the required parts

Item numbers can be found in the spare parts list.

Refer to the nameplate on the pump casing for most of the information. See Parts List for item numbers.

Nameplate types

Nameplate	Description
Pump casing	Provides information about the hydraulic characteristics of the pump.

Nameplate	Description
Pump	The formula for the pump size is: Discharge x Suction - Nominal Maximum Impeller Diameter in inches. (Example: 2x3-8)
Bearing frame	Provides information about the lubrication system used.
Ex	If applicable, your pump unit might have an Ex nameplate affixed to the pump, the baseplate, or the discharge head. The nameplate provides information about the Ex specifications of this pump.

Nameplate on the pump casing using English units

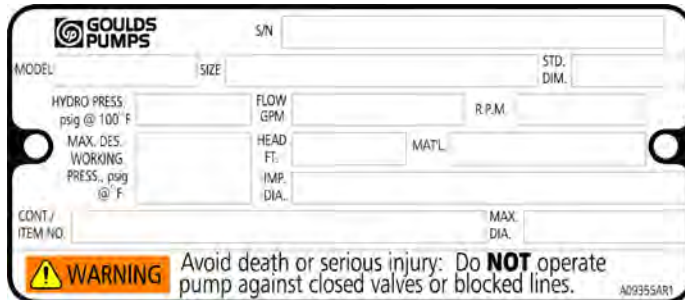


Figure 10: Nameplate on the pump casing using English units

Table 4: Explanation of nameplate on the pump casing

Nameplate field	Explanation
IMPLR. DIA.	Impeller diameter, in inches
MAX. DIA.	Maximum impeller diameter, in inches
GPM	Rated pump flow, in gallons per minute
FT HD	Rated pump head, in feet
RPM	Rated pump speed, revolutions per minute
MOD.	Pump model
SIZE	Size of the pump
STD. NO.	ANSI standard designation
MAT L. CONST.	Material of which the pump is constructed
SER. NO.	Serial number of the pump
MAX DSGN PSI @ 100°F	Maximum pressure at 100°F according to the pump design

Nameplate on the pump casing using metric units

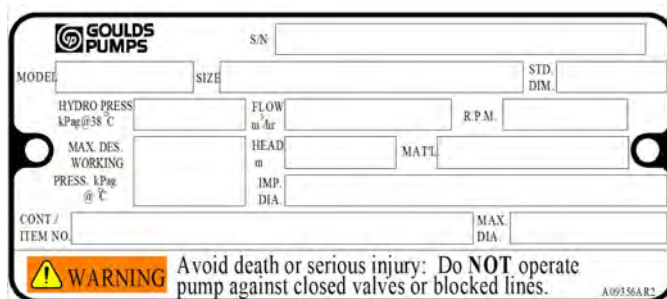
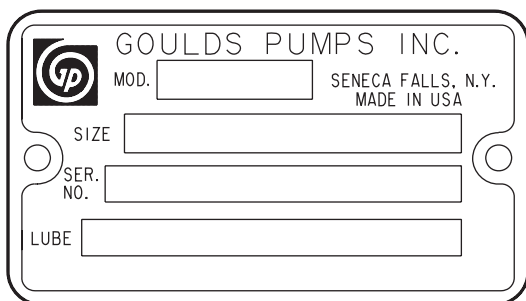


Figure 11: Metric units - nameplate on pump casing

Table 5: Explanation of the nameplate on the pump casing

Nameplate field	Explanation
IMPLR. DIA.	Impeller diameter
MAX. DIA.	Maximum impeller diameter
M ³ /HR	Rated pump flow, in cubic meters per hour
M HD	Rated pump head, in meters
RPM	Rated pump speed, in revolutions per minute
MOD.	Pump model
SIZE	Size of the pump
STD. NO.	ANSI standard designation
MAT L. CONST	Material of which the pump is constructed
SER. NO.	Serial number of the pump
MAX. DSGN kPag @ 20°C	Kilopascal at 20°C

Nameplate on the bearing frame**Figure 12: Nameplate on the bearing frame****Table 6: Explanation of the nameplate on the bearing frame**

Nameplate field	Explanation
BRG. O. B.	Outboard bearing designation
BRG. I. B.	Inboard bearing designation
S/N	Serial number of the pump
LUBE	Lubricant, oil or grease

Ex nameplate

All pumping unit (pump, seal, coupling, motor and pump accessories) certified for use in an Ex classified environment, are identified by an Ex tag secured to the pump or baseplate on which it is mounted. A typical tag would look like this:

**Figure 13: Typical Ex nameplate****Figure 14: Typical UKCA Ex nameplate**

Table 7: Temperature class definitions

Code	Maximum permissible surface temperature in °C °F	Maximum permissible liquid temperature in °C °F
T1	440 824	372 700
T2	290 554	267 513
T3	195 383	172 342
T4	130 266	107 225
T5	Option not available	Option not available
T6	Option not available	Option not available

ISO 80079-37:2016 Section 5.7

Recommended bearing replacement interval (based on L10 life) = 17,500 hours of operation.

The code classification marked on the equipment should be in accordance with the specified area where the equipment will be installed. If it is not, please contact your ITT/Goulds representative before proceeding.

**WARNING:**

Use of equipment unsuitable for the environment can pose risks of ignition and/or explosion. Ensure the pump driver and all other auxiliary components meet the required area classification at the site. If they are not compatible, do not operate the equipment and contact an ITT representative before proceeding.

4 Installation

4.1 Pre-installation

Precautions



WARNING:

- When installing in a potentially explosive environment, ensure that the motor is properly certified.
 - All equipment being installed must be properly grounded to prevent unexpected discharge. Discharge can cause equipment damage, electric shock, and result in serious injury. Test the ground lead to verify it is connected correctly.
-

NOTICE:

- Electrical connections must be made by certified electricians in compliance with all international, national, state and local regulations.
 - Supervision by an authorized ITT representative is recommended to ensure proper installation. Improper installation may result in equipment damage or decreased performance.
-

4.2 Location

Pumping unit should be placed as close as practical to the source of supply. Floor space and head room allotted to the unit must be sufficient for inspection and maintenance. Be sure to allow for crane or hoist service. On horizontally split case pumps, always allow sufficient head room to remove the upper half casing

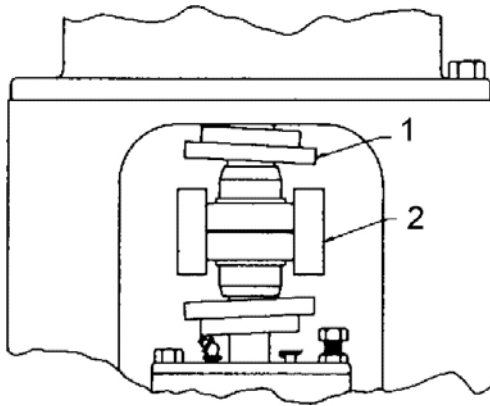
4.3 Install Close-Coupled and Vertical Pumps

1. Close Coupled
 - a) A "close-coupled" pump may be mounted horizontally or in a vertical position provided motor is above pump.
 - b) The unit should be bolted to a concrete foundation or an adequately supported structure, substantial enough to absorb any vibration and to form a permanent rigid support for the unit. All units have holddown bolt holes in the motor feet and pump/ adapter feet. Depending upon the motor frame, the pump or adapter feet may be higher or lower than the motor feet.
 - c) Shim as required, then bolt all feet securely to support or foundation. Since the pump is mounted on the motor, permanent alignment is "built in". No subsequent alignment is necessary.
2. Vertical
 - a) Vertical pumps may be mounted directly on a pit, using either the pump support plate only or in conjunction with a pit or tank cover. The units are shipped completely assembled except for motor, pit cover (if any), and float controls.
 - b) Check all bolts and nuts on the entire unit to make sure they are securely tightened.
 - c) Connect float and controls as shown in sectional view at [8.3 Parts List on page 86](#).
3. Installation must be done with care to avoid damage and insure proper operation. It is recommended that a man be stationed inside the pit, whenever possible, to assist in the initial installation.

4. Lower the assembled pump (less motor) carefully into the pit. Guide unit carefully so that it does not strike sides of pit. When unit is in place, level the support plate. Shim under support plate as required. Pump must hang perfectly vertical to avoid placing a bending stress on the unit.
5. The support plate should be bolted to an adequately supported structure, substantial enough to absorb any vibration and to form a permanent, rigid support for the unit.
6. Place motor on motor support and tighten bolts (with lock washers) snugly.
7. Check for alignment by laying a straight edge across coupling hubs at four points 90° apart. See image below. When the straight edge rests evenly at all four points, the coupling is aligned.

NOTICE:

Alignment of the coupling is of extreme importance for trouble-free mechanical operation.



1. Coupling cover

2. Straight edge

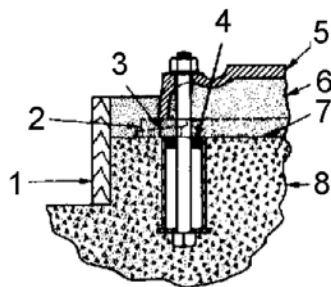
Figure 15: Coupling Alignment

8. The machined faces of the motor support and motor will provide angular alignment. However, any foreign material or burrs on the surface will destroy this alignment. Make sure surfaces are clean and smooth.

4.4 Install Horizontal Pumps

Bed plate mounted units are normally mounted on a concrete foundation of liberal thickness poured on a solid footing, using a one-three-five mix. The foundation should be substantial in order to absorb any vibration and to form a permanent, rigid support for the pumping unit.

1. The location and size of foundation bolts are shown on the outline assembly drawing supplied for the unit.
2. When unit is mounted on a concrete foundation, each foundation bolt should be installed with a pipe sleeve around it to allow for adjustment.
 - a) Place a washer between the bolt head and sleeve to hold bolts. See image below.



- | | |
|--|--|
| 1. Dam | 5. Bedplate |
| 2. Wedges | 6. Grout |
| 3. Leave 3/4" to 1-1/2" under bedplate for grout | 7. Leave top of foundation rough and wet before grouting |
| 4. Waste | 8. Concrete foundation |

Figure 16: Concrete Foundation

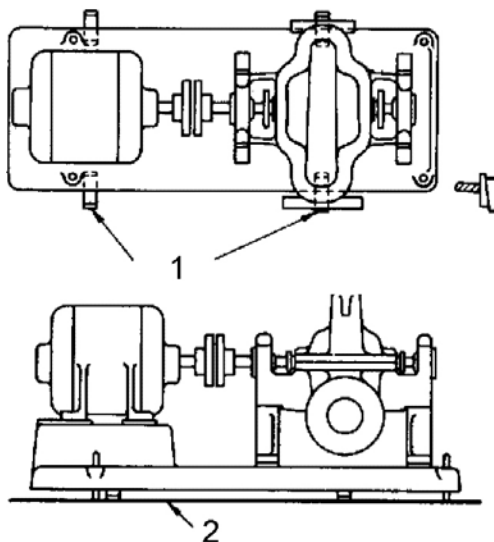
The I. D. of the sleeve should be 2 1/2 - 3 times the bolt diameter.

- b) Stuff waste around bolts to prevent concrete from entering between bolt and sleeve. Bolts should be of sufficient length so that they project through the nuts approximately 1/4" after allowance has been made for grouting, bedplate thickness, and nut thickness.

NOTICE:

Remove all dirt from the mounting pads in order to ensure that the correct leveling is achieved. Failure to do so can result in equipment damage or decreased performance.

3. Put the unit in place on wedges. The wedges should be placed at four points as shown in the image below. Some long installations may require additional wedges near the middle of the bedplate.



- | | |
|-----------|---------------|
| 1. Wedges | 2. Foundation |
|-----------|---------------|

Figure 17: Wedge placement

4. Disconnect coupling between pump and driver.

NOTICE:

"Spider-Insert" couplings, as shown in the image below, need not be disconnected.

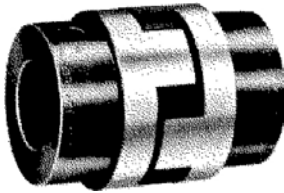


Figure 18: Spider-Insert Couplings

5. By adjustment of wedges, bring the bedplate to an approximate level and provide the proper distance above the foundation for grouting 10.05mm to 38.1mm | 3/4" to 1-1/2". Level or plumb the suction and discharge flanges. Bring pump and motor shafts into reasonable alignment making absolutely certain that motor shaft is not above pump shaft or if it is, that there is a sufficient thickness of shims under the motor feet to allow for adjustment during alignment.
6. Tighten foundation bolts, but only finger tight. Maintain the level of the bedplate.

NOTICE:

Final tightening is done after pump is grouted and grout has set at least 48 hours.

7. Build wood dam around foundation as shown in [Figure 16: Concrete Foundation on page 22](#), and thoroughly wet top surface of foundation. Pour grout in hole provided in top of bedplate. Use of non-shrink grout is recommended. Grout should be thin enough to flow out under the bedplate but not so wet that sand and cement will separate. Grout should be puddled continuously as it is poured to expel the air and completely fill the space under the bedplate to the level of the grout hole. Strike along top of dam with trowel to give a neat finished appearance. Allow grout to harden at least 48 hours.
8. Tighten foundation bolts.
9. Tighten pump hold-down bolts.

4.5 Pump-to-driver alignment

Precautions

**WARNING:**

- Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
 - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
 - Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.

4.5.1 General Alignment Procedures

Alignment of the pump and driver is of extreme importance for trouble-free mechanical operation. The following are suggested steps to establish the initial alignment of the unit.

NOTICE:

This is an initial alignment. The final alignment is done after the unit has been run under actual operating conditions. The final alignment procedure is outlined in [5.21 Final Alignment on page 55](#) and must be followed. Make sure: motor starting switch is "locked out" to prevent accidental rotation.

Any coupling manufacturer's instruction sheets, sent with the pump, should be studied and used when installing, aligning, or servicing coupling. Note that coupling hubs are not necessarily mounted flush with the shaft ends.

If instructions are not available, the following procedure may be used. The procedure is given for two basic coupling types:

1. Flexible Coupling - Normally furnished on all units except "back pull-out". Normally not assembled (except "spider-insert" type which are preassembled) .
2. Flexible Spacer Coupling - Furnished as standard on all "back pull-out" units. Contains a removable spacer piece located between coupling hubs.

NOTICE:

Note that alignment in one direction may alter alignment in another. Check through each alignment procedure after making any alignment alteration.

4.5.1.1 Parallel Alignment

1. Unit is in parallel misalignment when the shaft axes are parallel but not concentric. Shift driver as required.
2. In order to obtain vertical parallel alignment under actual operating conditions, the driver shaft may have to be set higher or lower (using thin shim stock) than the pump shaft due to differences in expansion rates. Pump expansion rates vary with pump design. The following is a suggested cold setting for motor driven units:

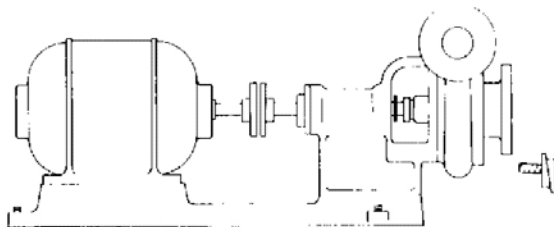


Figure 19: Frame Mounted Units

Option	Description
Pumpage Temperature	Set
Above Ambient	Motor
Temperature	Shaft

Option	Description
Ambient	0.102mm - 0.152mm 0.004" - 0.006" Low
38°C 100°F	0.051mm - 0.102mm 0.002" - 0.004" Low
93°C 200°F	0.000mm - 0.051mm 0.000" - 0.002" Low
149°C 300°F	0.000mm - 0.051mm 0.000" - 0.002" High

Set motor shaft .002"-.004" low regardless of pumpage temperature.

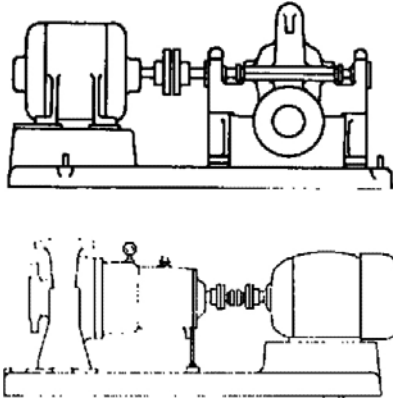


Figure 20: Pedestal Mounted Units

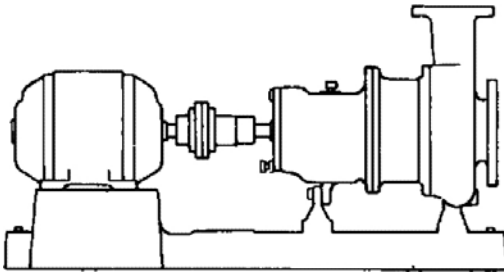


Figure 21: Casing Mounted Units

Option	Description
Pumpage Temperature	Set
Above Ambient	Motor
Temperature	Shaft

Option	Description
Ambient	0.051mm - 0.102mm 0.002" - 0.004" Low
38°C 100°F	0.000mm - 0.051mm 0.000" - 0.002" High
93°C 200°F	0.102mm - 0.152mm 0.004" - 0.006" High
149°C 300°F	0.203mm - 0.254mm 0.008" - 0.010" High
204°C 400°F	0.305mm - 0.356mm 0.012" - 0.014" High
260°C 500°F	0.406mm - 0.457mm 0.016" - 0.018" High

3. To check the parallel alignment:

- a) Flexible Couplings: Place a straight edge across both coupling hubs at four points 90° apart. The unit will be in parallel alignment when the straight edge rests evenly on both halves. See image below.
- b) "Spider-Insert" Couplings: Place a straight edge across both coupling hubs at four points 90° apart. The unit will be in parallel alignment when the straight edge rests evenly on both halves. See image below.

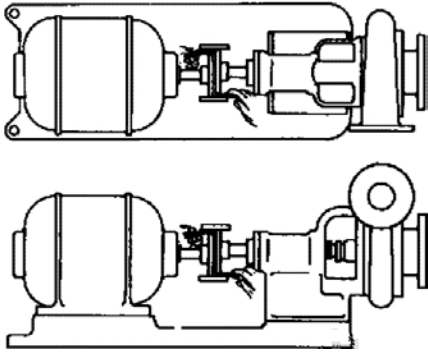
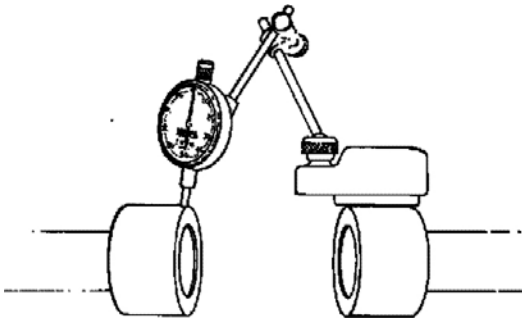


Figure 22: Parallel Alignment with Straight edge

- a) Flexible Spacer Couplings: Place a dial indicator on one hub and rotate that hub 360° while taking readings on the outside diameter of the other hub. When indicator does not deflect more than 0.051mm | 0.002" total, parallel alignment is achieved. See image below.

Figure 23: Parallel Alignment with Dial Indicator



4.5.1.2 Angular Alignment

1. Unit is in angular misalignment when the shaft axes are concentric, but not parallel. Shim unit as required.
 - a) Flexible Couplings: The normal "gap" (distance between coupling halves) is approximately 3.175mm | 1/8". However, the coupling manufacturer's instructions should be followed. Insert a "feeler" or taper gauge at 90° intervals on the circumference of the hubs. When the "gap" is identical within 0.051mm | .002", the unit is in angular alignment. See image below.

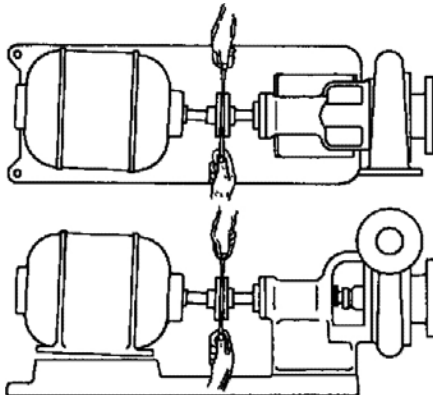


Figure 24: Angular Alignment with Flexible Couplings

- b) Spider Couplings: The normal "gap" (distance between hub and insert) is approximately 1.588mm | 1/16". However, the coupling manufacturer's instructions should be followed. Check

alignment by using calipers at 90° intervals on the circumference on the outer end of hubs. When caliper measurements are identical, the unit is in angular alignment. See image below.

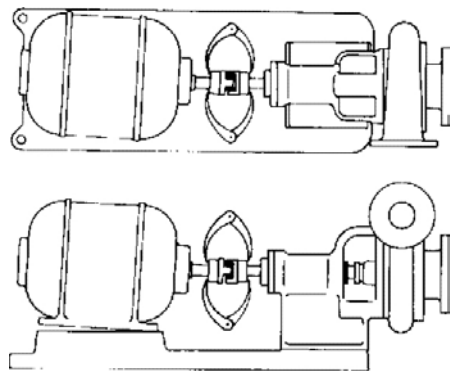


Figure 25: Angular Alignment with Calipers

- c) Flexible Spacer Couplings: Place a dial indicator on one shaft hub and rotate that hub 360°. Take readings from the face of the other hub. Alignment is achieved when indicator does not deflect more than .002". See image below.

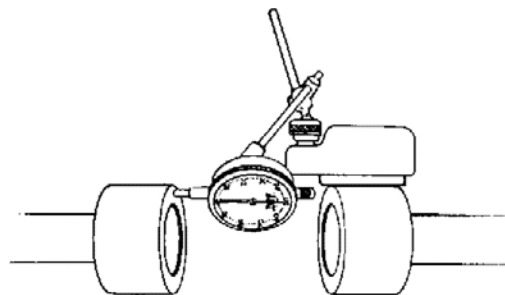


Figure 26: Angular Alignment with Dial Indicator

4.6 General Piping



WARNING:

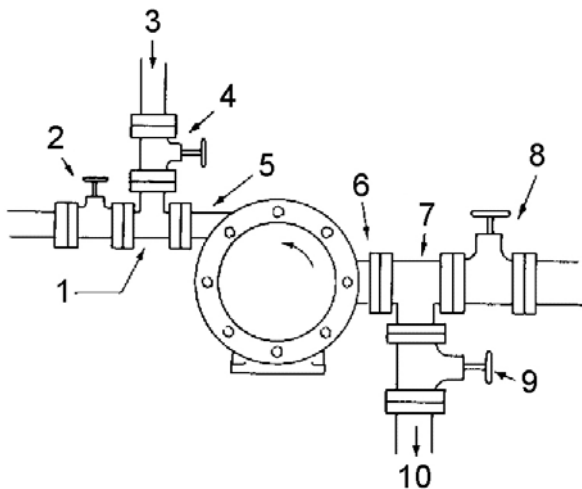
- Risk of premature failure. Casing deformation can result in misalignment and contact with rotating parts, causing excess heat generation and sparks. Flange loads from the piping system, including those from the thermal expansion of the piping, must not exceed the limits of the pump.
 - Risk of serious personal injury or property damage. Fasteners such as bolts and nuts are critical to the safe and reliable operation of the product. Ensure appropriate use of fasteners during installation or reassembly of the unit.
 - Use fasteners of the proper size and material only.
 - Replace all corroded fasteners.
 - Ensure that all fasteners are properly tightened and that there are no missing fasteners.
1. All piping must be supported independently of the pump. The piping should always "line-up" naturally with the pump flanges. Never draw the piping into place by use of force at the flanged suction and discharge connections of the pump, as this may impose dangerous strains on the unit and cause misalignment between pump and driver.

2. The piping, both suction and discharge, should be as short and direct as possible. Avoid all unnecessary elbows, bends, and fittings, as they increase the friction losses in the piping. The size of pipe and fittings should be carefully selected and of sufficient size to keep the friction losses as low as practical.
3. Piping must not be connected to the pump until the grout has thoroughly hardened and the foundation bolts, as well as driver and pump hold down bolts have been tightened.
4. When handling liquids at elevated temperatures, it is suggested that expansion loops or joints be properly installed in suction and/or discharge lines so that linear expansion of the piping will not draw the pump out of alignment.

If such expansion loops or joints are not used, the forces and moments, due to thermal expansion of the piping system, that can act upon the pump inlet and discharge flanges must be determined and must not exceed the limits permissible for the specific pump in question.

Such installations require extremely careful and precise attention to hot alignment procedures. See [5.21 Final Alignment on page 55](#).

5. On units handling corrosives, the piping can be arranged so that corrosives can be flushed from pump prior to opening unit for service. See image below. During operation, valves "1" and "3" would be closed, "2" and "4" open. Prior to dismantling, close valves "2" and "4", open "1" and "3". Introducing water at valve "3" will allow water to flush pump and drain at valve "1".



- | | |
|----------------|--------------|
| 1. Tee | 6. Suction |
| 2. Valve "A" | 7. Tee |
| 3. Flush water | 8. Valve "2" |
| 4. Valve "3" | 9. Valve "1" |
| 5. Discharge | 10. To waste |

Figure 27: Piping

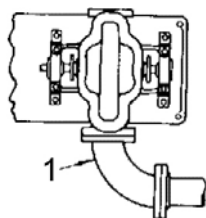
4.7 General Suction Piping

Properly installed suction piping is of extreme importance for trouble-free centrifugal pump operation.

1. Use of elbows close to the pump suction flange should be avoided. Where used, elbows should be long radius.

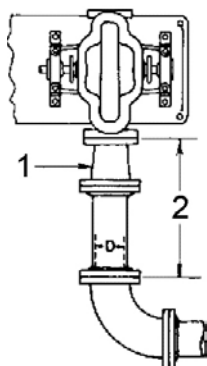
On double suction pumps, if an elbow must be used at the pump suction flange, it must be in a vertical position only. If an elbow must be used in other than a vertical position, it is permissible

only providing there is a minimum of two diameters of straight pipe between the elbow and pump suction flange.



1. Elbow must be vertical when next to pump

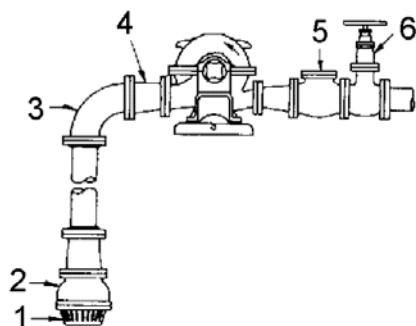
Figure 28: Wrong



1. Eccentric reducer - with top horizontal
2. Must be at least 2D

Figure 29: Recommended

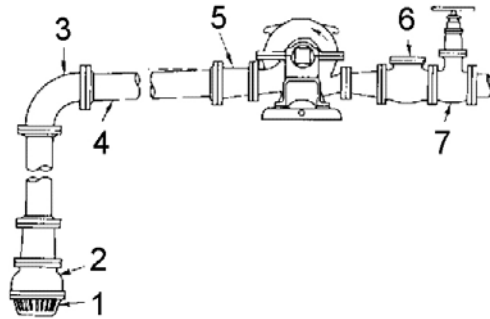
2. The suction pipe should never be of smaller diameter than the pump suction. Use of suction pipe one or two sizes larger than the pump suction, with a reducer at the pump suction flange, is desirable.
3. Reducers, if used, should be eccentric and preferably at the pump suction flange, sloping side down.



1. Strainer
2. Foot valve (if used)
3. Long radius elbow

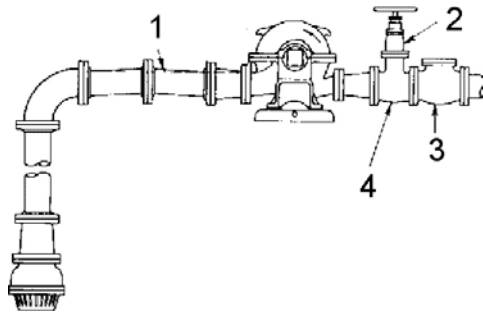
4. Eccentric reducer
5. Check valve
6. Gate valve

Figure 30: Correct Piping



- | | |
|--|----------------------|
| 1. Strainer | 5. Eccentric reducer |
| 2. Foot valve (if used) | 6. Check valve |
| 3. Long radius elbow | 7. Gate valve |
| 4. Suction pipe slopes upwards from source of supply | |

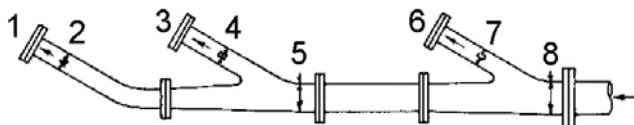
Figure 31: Correct Piping



1. Air pocket because eccentric reducer is not used and because suction pipe does not slope gradually upward from supply
2. Gate valve
3. Check valve
4. Gate valve should not be between check valve and pump

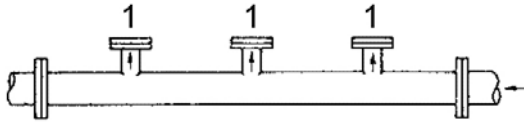
Figure 32: Incorrect Piping

4. A centrifugal pump should never be throttled on the suction side.
5. Suction strainers, when used, should have a net "free area" of at least three times the suction pipe area.
6. Separate suction lines should be used when more than one pump is operating from the same source of supply. If it is not possible to have separate lines, see recommended piping arrangement shown in the image below.



- | | |
|-------------|---------------------------------|
| 1. Pump | 5. Area = "A" + "B" (min) |
| 2. Area "A" | 6. Pump |
| 3. Pump | 7. Area "C" |
| 4. Area "B" | 8. Area = "A" + "B" + "C" (min) |

Figure 33: Recommended Piping Arrangement (when separate suction lines are not possible)



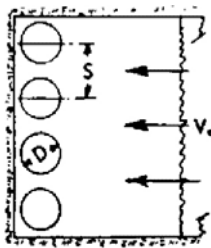
1. Pump

Figure 34: Incorrect Piping Arrangement

4.8 Suction Piping Design for Large Pumps

Large units taking their suction supply from sumps require special attention. A properly designed sump is a must. The larger the unit, the more important these considerations become. A 3000 GPM pump should be considered a large unit.

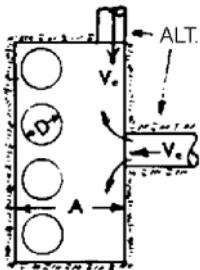
The following sketches will show the preferred pipe arrangement within the sump. Pipe should be located near the back wall of the sump as shown in image below and should not be subjected to rapid changes in direction of the flow pattern.



$V_e = 1\text{fps or less}$

$S = 1\text{-}1/2 \text{ to } 2D$

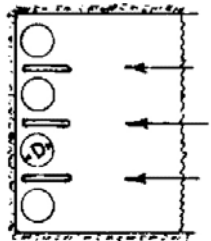
Figure 35: Recommended Pipe Arrangement



$V_e = 2\text{fps and up}$

If $A = \text{less than } 8D$

Figure 36: Not Recommended



Add wall thickness to centerline distance round or ogive wall ends. Gap at rear of wall appx. $D/3$

Figure 37: Recommended

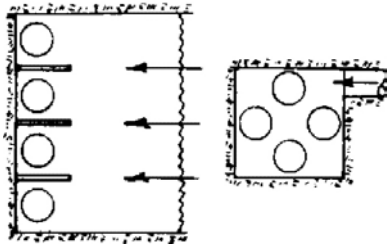
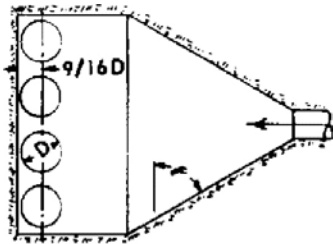


Figure 38: Neither Recommended



Min $O^C = 45^\circ$

Preferred $O^C = 75^\circ$

Figure 39: Recommended

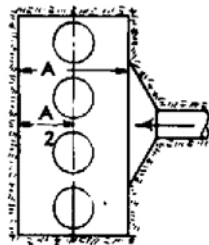


Figure 40: Not Recommended

The velocity of the water approaching the pump suction pipe should be kept to a maximum of one foot per second to avoid air being drawn into the pump. Pump suction inlet velocities and submergence (the height of the water above the pump inlet) are two additional factors that must be considered. These factors vary so greatly with the size and capacities of the individual pumps and systems that past experience, or a good reference, should be relied upon in arriving at these values.

The suction pipe should be sized to obtain a flow velocity of 4 to 7 feet per second. Changes in flow direction should be avoided wherever possible, especially near the pump suction. A reducer at the pump suction flange to smoothly accelerate and stabilize flow into the pump is desirable.

Refer to the nearest Goulds representative for further information.

4.8.1 Installations with Pump Above Source of Supply - Suction Lift

1. Keep suction pipe free from air pockets - See [Figure 32: Incorrect Piping on page 30](#).
2. Piping should slope upwards from source of supply.
3. No portion of piping should extend above the pump suction nozzle.
4. All joints must be air tight.

4.8.2 Installations with Pump Below Source of Supply - Suction Head or Flooded Suction

1. A gate valve should be installed in the suction line to permit closing of the line for pump inspection and maintenance.

2. Keep suction pipe free from air pockets.

4.9 Discharge Piping

1. Gate and check valves should be installed in the discharge line. The check valve should be located between the gate valve and pump to permit inspection of the check valve. The gate valve is required for priming, regulation of flow and for inspection and maintenance of the pump. The check valve is required to prevent reverse flow through the pump when the driver is turned off.
2. Increasesers, if used in discharge line, should be placed between the pump and check valves.
3. If quick-closing valves are installed in the system, cushioning devices should be used to protect the pump from surges and water hammer.

4.10 Connection of Piping

1. Connect suction and discharge piping to the pump.
2. Rotate pump shaft several times by hand to be sure there is no binding and that all parts are free.
3. Recheck alignment.

NOTICE:

On non-metallic pumps, use gaskets which are suitable for the flanges. PTFE envelope style is recommended.

4.11 Rotation



WARNING:

- Starting the pump in reverse rotation can result in the contact of metal parts, heat generation, and breach of containment. Ensure correct driver settings prior to starting any pump.
- Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
 - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
 - Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.

NOTICE:

Serious damage may result if pump is run in wrong direction.

1. Before coupling is connected, the motor should be wired and the direction of rotation checked.
2. The direction of rotation is marked on the pump. Make sure driver rotates in the same direction.

4.12 Connection of Coupling



WARNING:

Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.

4.13 Install the coupling guard

- Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
 - Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.
-

1. Connect coupling. Follow the manufacturer's instructions.
"Spider-Insert" type couplings are pre-assembled.
 2. If a coupling guard is furnished with the unit, make sure it is securely fastened.
-



WARNING:



- The coupling guard used in an Ex classified environment must be properly certified and constructed from a spark resistant material.
 - Running a pump without safety devices exposes operators to risk of serious personal injury or death. Never operate a unit unless appropriate safety devices (guards, etc.) are properly installed. See specific information about safety devices in other sections of this manual.
-

4.13 Install the coupling guard



WARNING:

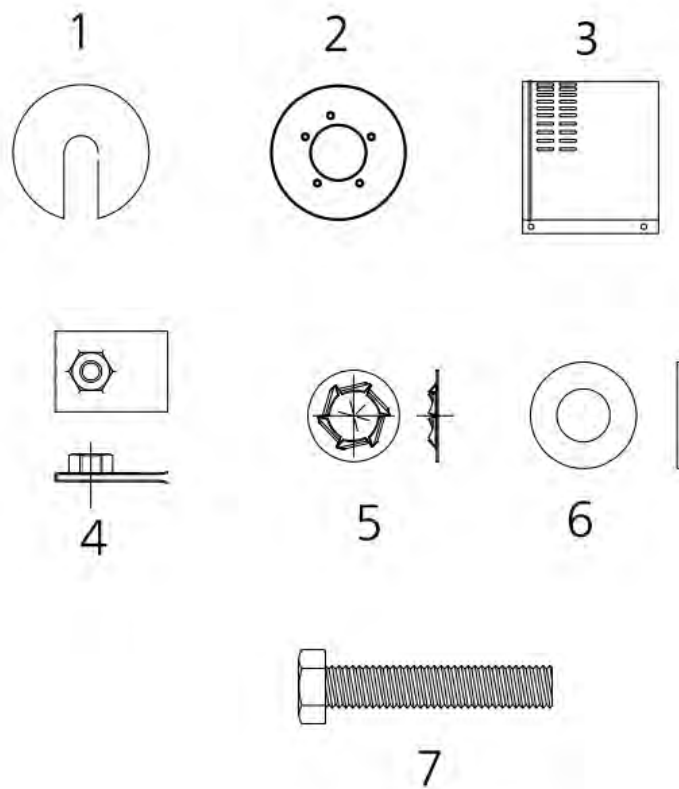
- Running a pump without safety devices exposes operators to risk of serious personal injury or death. Never operate a unit unless appropriate safety devices (guards, etc.) are properly installed.
 - Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
 - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
 - Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.
-



WARNING:

The coupling guard used in an Ex classified environment must be properly certified and constructed from a spark resistant material.

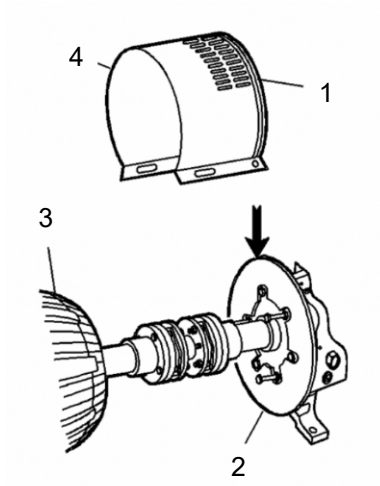
Required parts:



Part No.	Description	Part No.	Description
1	Cover driver	5	Retainer (Qty 3)
2	Cover pump	6	Washer (Qty 4)
3	Guard (Qty 2)	7	Hex head bolt (Qty 3)
4	U-nut (Qty 3)		

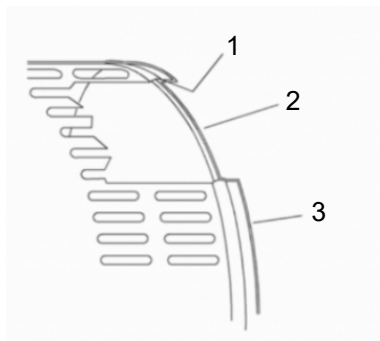
Figure 41: Required parts

1. De-energize the motor, place the motor in a locked-out position, and place a caution tag at the starter that indicates the disconnect.
2. Put the pump-side end plate in place.
If the pump-side end plate is already in place, make any necessary coupling adjustments and then proceed to the next step.
3. Slightly spread the opening of the coupling guard half and place it over the pump end plate.
 - a) The annular groove in the guard is located around the end plate.
 - b) Position the opening (flange) so that it does not interfere with the piping but still allows for access when you install the bolts.



Item	Description
1.	Annular groove
2.	Pump-side end plate
3.	Driver
4.	Pump half of the coupling guard

Figure 42: Align pump end guard half with annular groove



Item	Description
1.	Annular groove
2.	End plate (pump end)
2.	Guard half

Figure 43: Annular groove in coupling guard

4. Place one washer over the bolt and insert the bolt through the round hole at the front end of the guard half.

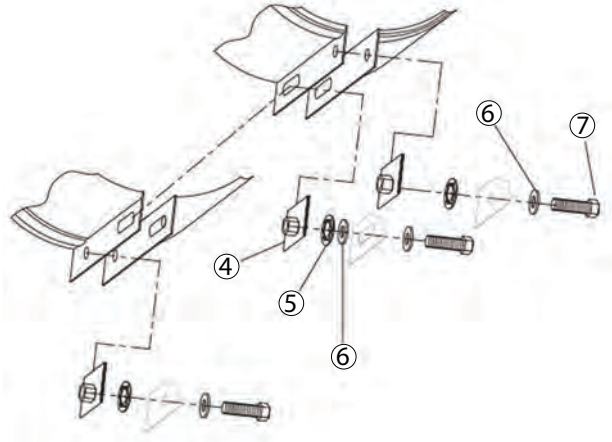


Figure 44: Captured hardware component assembly

5. Install the bolt retainer over the exposed end of the bolt, and the U-Nut into the slot in the coupling guard if it was not done from the factory.
6. Thread bolt into the U-Nut and tighten firmly.
7. Slightly spread the opening of the remaining coupling guard half and place it over the installed coupling guard half so that the annular groove in the remaining coupling guard half faces the motor.

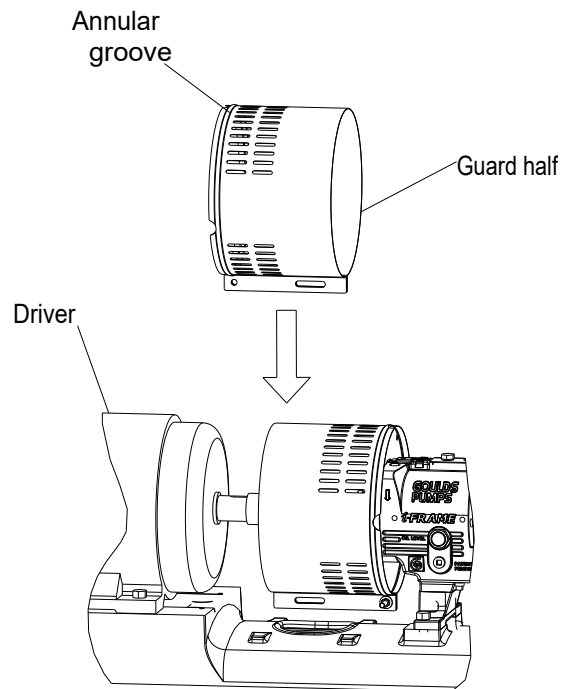


Figure 45: Placement of driver half of coupling guard

8. Place the end plate over the driver shaft and locate the end plate in the annular groove at the rear of the coupling guard half.

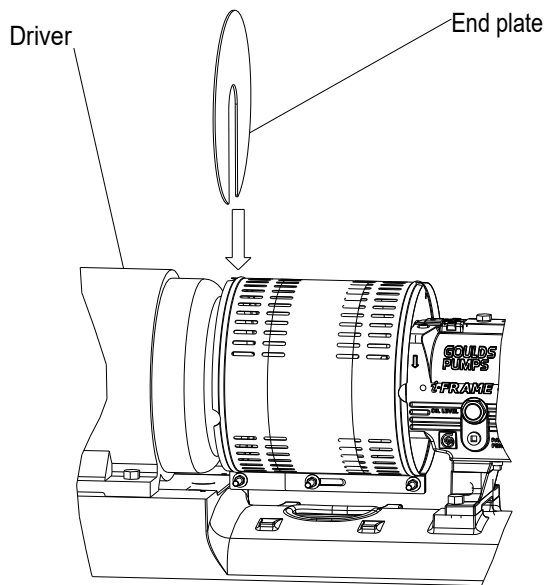


Figure 46: Placement of driver half of coupling guard

9. Hand-tighten only. Repeat Steps 4 through 6 for the rear end of the coupling guard half. The hole is located on the driver-side of the coupling guard half.
10. Slide the driver-half of the coupling guard towards the motor so that the coupling guard completely covers the shafts and coupling.

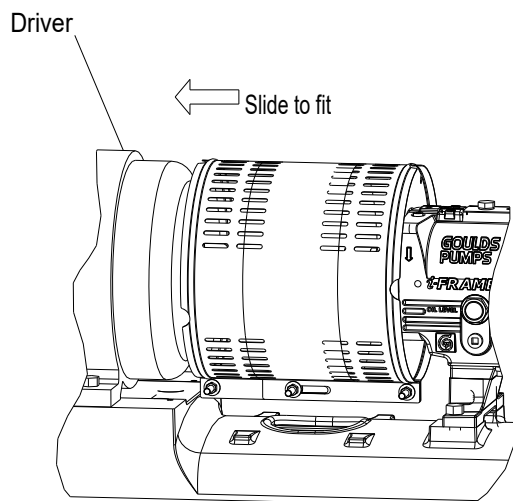


Figure 47: Slide driver-half of coupling guard towards motor

11. Repeat Steps 4 through 6 for the center slots in the coupling guard.
12. Tighten all nuts on the guard assembly.

5 Commissioning, Startup, Operation, and Shutdown

5.1 Preparation for startup



WARNING:

- Risk of serious physical injury or death. Exceeding any of the pump operating limits (e.g. - pressure, temperature, power, etc.) could result in equipment failure, such as explosion, seizure, or breach of containment. Assure that the system operating conditions are within the capabilities of the pump.
 - Risk of death or serious injury. Leaking fluid can cause fire and/or burns. Ensure all openings are sealed prior to filling the pump.
 - Breach of containment can cause fire, burns, and other serious injury. Failure to follow these precautions before starting the unit may lead to dangerous operating conditions, equipment failure, and breach of containment.
 - Risk of explosion and serious physical injury. Do not operate pump with blocked system piping or with suction or discharge valves closed. This can result in rapid heating and vaporization of pumpage.
 - Risk of breach of containment and equipment damage. Ensure the pump operates only between minimum and maximum rated flows. Operation outside of these limits can cause high vibration, mechanical seal and/or shaft failure, and/or loss of prime.
-



WARNING:

- Risk of death, serious personal injury, and property damage. Heat and pressure buildup can cause explosion, rupture, and discharge of pumpage. Never operate the pump with suction and/or discharge valves closed.
 - Running a pump without safety devices exposes operators to risk of serious personal injury or death. Never operate a unit unless appropriate safety devices (guards, etc.) are properly installed.
 - Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
 - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
 - Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.
-

Precautions

WARNING:

The mechanical seal used in an Ex-classified environment must be properly certified.

**CAUTION:**

When a cartridge mechanical seal is used, ensure that the set screws in the seal locking ring are tightened and that the centering clips have been removed prior to startup. This prevents seal or shaft sleeve damage by ensuring that the seal is properly installed and centered on the sleeve.

NOTICE:

- Verify the driver settings before you start any pump. Refer to the applicable drive equipment IOMs and operating procedures.
 - Excessive warm-up rates can cause equipment damage. Ensure the warm-up rate does not exceed 1.4°C | 2.5°F per minute.
-

NOTICE:

You must follow these precautions before you start the pump:

- Flush and clean the system thoroughly to remove dirt or debris in the pipe system in order to prevent premature failure at initial startup.
-

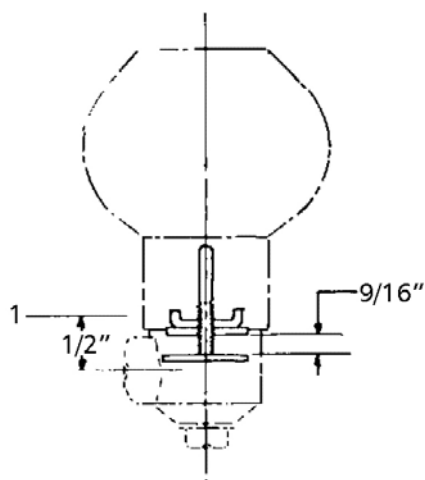
5.2 Pump Bearings

Oil Lubrication

**WARNING:**

Risk of explosive hazard and premature failure from sparks and heat generation. Ensure bearings are properly lubricated prior to startup.

Oil lubricated pumps are not lubricated at the factory. A high quality turbine type oil, with rust and oxidation inhibitors, should be used. Constant level oilers are supplied with most oil lubricated pumps. They are included in the box of fittings which accompanies the pump. The oiler was adjusted to maintain proper oil level before leaving the factory. The adjustment should be checked in case this setting was disturbed. See image below. Check the assembly dimension print for proper location.



1 - Oil level

Figure 48: Oiler

Instructions

1. Remove adjustment assembly from oiler
2. Adjust bars to 9/16"
3. Lock in position
4. Replace adjustment assembly in oiler

Under normal operating conditions, an oil of 300 SSU viscosity at 38°C | 100°F. (approximately SAE-20) should be used. For extreme conditions refer to the factory or a lubrication expert for a recommendation.

Fill the bottle with the proper grade of oil and replace in the oiler housing. Oil reservoir in bearing housing is filled when an oil level remains in the bottle. Several fillings of bottle will be required. Never fill through the oil vent or through the oiler without use of the bottle.

Grease Lubrication

NOTICE:

Grease can settle in equipment left idle leaving bearings improperly lubricated. Check the greasing on a pump that has been out of service for a long period of time and re-grease if necessary.

Grease lubricated pumps can be identified by the grease fittings located on the bearing housing. Sufficient lubricant is inserted at the factory for 2,000 hours of operation. Do not grease at too frequent intervals.

It is suggested that additional or replacement lubricant be added after 2,000 hours or at three-month intervals.

The lubricant should be renewed in the housings at least once annually. This should be done when the annual overhaul is made.

The grease should be of sodium lithium base, NGLI #2 consistency. Do not use graphite. Further greasing instructions are included in [6.2 Lubricate the Pump on page 62](#).

Vertical Pump Bearings

The bearing above the pump support plate is a ball bearing and is grease lubricated. Follow the previous instructions for grease lubrication.

The pump steady bearings (below the pump support plate) are sleeve type and made of various materials depending upon the application of the pump. See [6.2 Lubricate the Pump on page 62](#) for specific details.

Close-Coupled Pumps

"Close-coupled" pumps contain no pump bearings. The only bearings in the unit are contained within the motor. Make sure that the motor bearings are properly lubricated. Refer to the motor manufacturer for instructions.

5.3 Driver Bearing and Coupling

Check to be sure that driver bearings are properly lubricated. Contact the motor manufacturer for lubrication instructions. Refer to coupling instructions supplied separately for coupling lubrication.

5.4 Stuffing Box Packing



WARNING:



- Packed stuffing boxes are not allowed in an Ex-classified environment.
- Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
 - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
 - Refer to driver/coupling manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.

NOTICE:

Make sure to lubricate the packing. Failure to do so may result in shortening the life of the packing and the pump.

Before packing the stuffing box, make sure box is clean and contains no foreign material. If unit has a metal lantern ring, assembled with the pump, make sure ring is outside the stuffing box.

Stuffing box packing is furnished in the box of fittings which accompanies the pump. When packing the stuffing box, refer to the [8.3 Parts List on page 86](#) for the arrangement of packing rings and lantern ring. Depending upon the particular pump and/or application, the lantern ring may be in the middle or bottom of the stuffing box, incorporated in another part or not used at all.

Some packing rings are die-formed and special care must be taken during installation. To install, twist the ring sideways just enough to get it around the shaft or sleeve. Do not attempt to pull rings straight out. See image below. Another form of packing ring is the bulk-type packing which is cut to the proper length. Each piece should be placed around the shaft or sleeve and the ends of the packing should just meet to form a smooth, perfect ring. If necessary, the ends should be trimmed to obtain this fit.

**Figure 49: Correct****Figure 50: Incorrect**

There are two basic types of lantern rings - PTFE and metal. Two-piece PTFE lantern rings are supplied in most units. Install as shown below. Note: 2 pieces make one ring. Notches must face one another but need not be aligned.



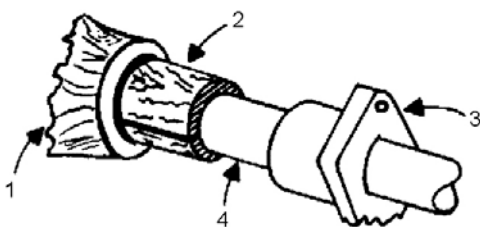
Correct



Incorrect

Figure 51: Metal Lantern Ring**Figure 52: PTFE Lantern Ring**

To pack the stuffing box, install the packing and lantern ring in the proper sequence. Each ring should be installed separately. Firmly seat each ring. Use of a wooden split bushing is recommended. See image below. Use gland to jack the bushing and ring into the box. Stagger joints in each ring 90°. Make sure center of lantern ring lines up with flush tap in the stuffing box. Any extra rings are spares.

**Figure 53: Wooden split bushing**

- | | |
|---------------------------|----------|
| 1. Stuffing box | 3. Gland |
| 2. Wooden "split bushing" | 4. Shaft |

Tighten the gland nuts evenly but not tight. Follow adjustment procedure outlined in [5.20 Initial Inspection After Starting on page 54](#).

5.5 Remove Packing

To remove packing from the stuffing box, the following steps should be followed:

**WARNING:**

Packed stuffing boxes are not allowed in an Ex-classified environment. Failure to disconnect and lock out driver power may result in serious physical injury. Never attempt to replace the packing until the driver is properly locked out.

1. Remove gland assembly.
2. Remove packing with a "packing hook."
3. Remove lantern ring by inserting a wire hook into the ring on the outer edge.
4. Clean the stuffing box.
5. On horizontally split case pumps, an alternate method of removing packing is to remove the upper half casing.
See [6.5 Disassemble the Pump on page 67](#).
 - a) Remove packing and lantern ring and inspect sleeves.
 - b) If deeply grooved, sleeves should be replaced.

5.6 Mechanical Seals

**WARNING:**

The mechanical seal used in an Ex-classified environment must be properly certified.

**CAUTION:**

The mechanical seal used in an Ex-classified environment must be properly certified.

Running a mechanical seal dry, even for a few seconds, can cause seal failure and physical injury. Never operate the pump without liquid supplied to the mechanical seal.

When mechanical seals are furnished, the description and identification is indicated on the order write-ups which are a part of the order acknowledgement, dimension print, and the packing list. Separate seal manufacturers' installation drawings are attached to the pump. The seals are installed and adjusted at the factory. The manufacturer's drawings should be filed for future use in maintaining the seal and in adjusting the seal when the pump is disassembled. To properly prepare the seal for operation, various cooling and flushing flows may have to be connected. In some cases, these flows are recirculated from the pump casing; in others, liquid from an outside source may be used. Connect cooling and flushing flows to seal as directed in subsequent steps.

5.7 Install the shaft guard - if provided



WARNING:

- Running a pump without safety devices exposes operators to risk of serious personal injury or death. Never operate a unit unless appropriate safety devices (guards, etc.) are properly installed.
- Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
 - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
 - Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.

Exposed rotating shaft between pump seal and bearing frame. Avoid contact and/or install proper guarding. If guarding is not provided with the pump, contact Goulds for price and availability of proper guarding.

5.8 Connection of Sealing Liquid or Grease Lubricator (Packed Box)

If the stuffing box pressure is above atmospheric pressure, and the pumpage is dean, normal gland leakage of 40 to 60 drops per minute is usually sufficient to lubricate and cool the packing and sealing liquid is not required.

Sealing liquid or grease lubricator is required when:

1. Abrasive particles in the pumpage could score the shaft or sleeve.
2. Stuffing box pressure may be below atmospheric pressure due to pump running with suction lift, or when suction source is under vacuum. Under these conditions, the packing will not be cooled and lubricated and air will be drawn into the pump.

Sealing Liquid

Sealing liquid may be supplied by recirculation of pumpage through a line from the casing to the stuffing box. If the pumpage is abrasive, an outside source of clean compatible liquid must be used at a pressure of 30 to 50 PSI above suction pressure.

Grease Lubricator

The grease lubricator is supplied when the use of recirculating pumpage or outside sealing liquid is not desired. The grease should be insoluble in the pumpage.

5.9 Connection of Cooling Water Piping

Quench Gland

Most pumps which contain stuffing box packing have quench glands. Quenching prevents heat transfer along the pump shaft to the bearings. Quenching is also most important for smothering vapors and fumes given off at the stuffing box. This is particularly true on applications such as hot water.

The quenching liquid (usually water) must be from an outside source. It should be piped, with flexible pipe, into the tapped opening on top of the stuffing box gland. A shut-off valve should be installed.

Bearings

Bearing cooling is available on some units. When it is available, cooling water must be connected to the jacket when pumping hot liquids. See the temperature limits listed under "Construction Details" in [8.3 Parts List on page 86](#). Valves should be installed in the coolant supply lines to regulate the flow.

Stuffing Boxes

Some units are equipped with cooling jackets around the stuffing box as standard. It is optional on various other models. Coolant lines are connected in the same manner as the bearing cooling lines.

Casing Pedestals

On some models, water cooled pedestals are available. Connection of coolant lines is made in the same manner as above.

Mechanical Seals

Seal materials (carbon, ceramic, PTFE, etc.) are suitable for use at temperatures to 260°C | 500°F. (100°C to 121°C | 212°F to 250°F if seal has rubber parts). However, for satisfactory operation, there must be a liquid film between the seal faces to lubricate them. If the liquid flashes to vapor, the faces will run dry and be damaged. To prevent this, the liquid must be cool. In general, this requires that the liquid be cooled so that the vapor pressure is well below the stuffing box pressure. Doubtful cases should be referred to Goulds for a recommendation. Refer to seal manufacturer's drawing for location of taps. Some methods which may be used to cool the seal are:

1. Dead Ended Seal Chamber

No liquid is circulated through the stuffing box. The isolated or "dead ended" liquid around the seal is cooled by circulating water in the stuffing box jacket, if any.

2. Cool Liquid Flushing - External Source

A clean, cool compatible liquid is injected from an outside source directly into the seal chamber. The flushing liquid must be at a pressure 20 to 40 PSI greater than the pressure in the stuffing box. One-half to two GPM should be injected. A control valve and rotometer placed in the inlet line permits accurate regulation. Cooling water can be circulated through the stuffing box water jacket (if any) in addition to the external flush.

3. Cool Liquid Flushing - Product Cooling

In this arrangement, pumped liquid is piped from the pump casing, cooled in an external heat exchanger, then injected into the seal chamber. A control valve together with a rotometer and/or a dial thermometer should be installed in a line from the exchanger to the seal chamber. One-half to two GPM should be circulated. Cooling water, one to three GPM, should be circulated through the stuffing box jacket, if any.

5.10 Connection of Drain Piping

All units contain tapped openings around the stuffing box for draining leakage. On corrosion resistant units, a drain pan is supplied with a tapped opening. Check the assembly dimension print for size and location.

5.11 Connection of Equalizing Piping

Some multi-stage pumps have equalizing piping to equalize pressure on the stuffing boxes (see [8.3 Parts List on page 86](#)). This piping is in the box of fittings which accompanies the pump. The ends of the piping must be connected to the openings in each stuffing box.

5.12 Impeller Adjustment

Some end suction pumps, in addition to vertical pumps, have means of adjusting impeller clearance within the casing. The clearance was set at the factory, but in transit, the clearance may have been lost. Proper clearance must be attained before a pump is operated or serious damage may occur. Check and reset impeller clearance by method described in [6.3 Impeller Clearance Adjustment on page 64](#).

5.13 Check for Free Turning



WARNING:

- Starting the pump in reverse rotation can result in the contact of metal parts, heat generation, and breach of containment. Ensure correct driver settings prior to starting any pump.
- Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
 - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
 - Refer to driver/coupling manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.

1. Rotate shaft by hand to be sure rotating element is free. If element rubs or binds:
 - a) Check alignment.
 - b) Remove pipe loads.
 - c) Check impeller clearance (if external adjustment is possible) as outlined in [6.3 Impeller Clearance Adjustment on page 64](#).
 - d) If unit is equipped with leveling bolts on frame or casing foot, then check to be sure that bolts are not overtightened.

5.14 Regulation of Cooling and Flushing Liquids

The supply of liquid to any cooling jackets, quench glands, or mechanical seals should be regulated by valves in the supply line. Approximate flow rates are as follows:

- Quench Glands - ½ to 1 GPM
- Cooling Jackets - 1 to 3 GPM
- Mechanical Seals - ½ to 2 GPM

The cooling lines should be checked periodically to see that they have not become clogged.

5.15 Priming



WARNING:



These pumps are not self priming and must be fully primed at all times during operation. Loss of prime can lead to excessive heat and severe damage to the pump and seal.

The pump must always be fully primed and the suction pipe full of liquid before pump is started.

If pump is run dry, the rotating parts within the pump may seize to the stationary parts since they depend upon the liquid being pumped for lubrication.

Several different methods of priming can be used, depending upon the type of installation and service involved.

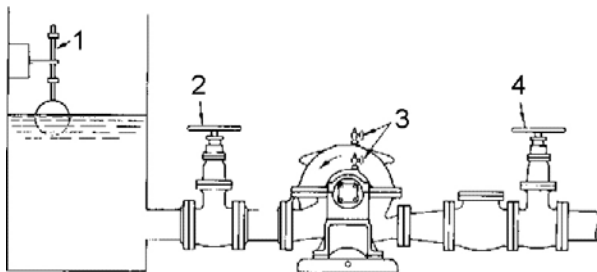
Vertical sump pumps, when submerged, need not be primed since the pump is filled with liquid.

NOTICE:

On glass-lined pumps, the thermal shock limit of the glass varies with the conditions of operation. Do not introduce liquid to pump if temperature difference between liquid and pump is 100°F. Gradually heat pump before introducing hot liquids.

1. Suction Supply Above Pump

When pump is installed as shown below, pump will prime itself.



1. Float switch

2. Suction gate valve

3. Air vent valves

4. Discharge gate valve

Figure 54: Self priming

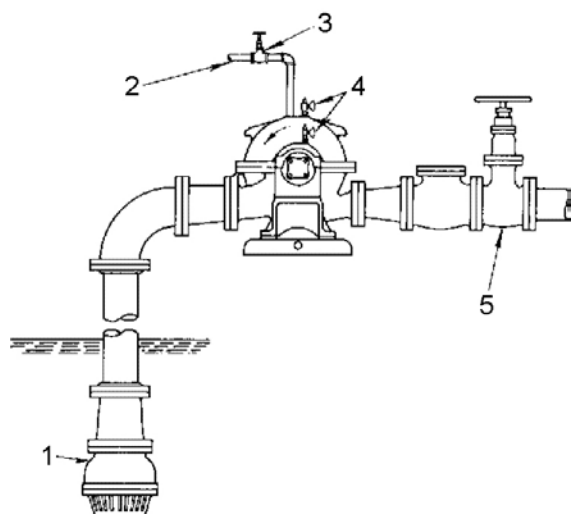
- a) Open gate valve on suction and discharge gate valve.
- b) Open air vent valves until all air is expelled and water flows through openings.
- c) Close air vent valves, start pump and open discharge gate valve. Pump will continue to be primed for any future starting.

This method is the simplest and, particularly for automatic operation, the safest. A float switch in the suction reservoir can be arranged to stop pump, should there be failure of liquid supply.

2. Prime with Foot Valve

With pump installed on suction lift, with foot valve at end of suction line, priming can be done any of the following three ways: In methods (1) and (2), the pump will remain primed, provided foot valve is tight. Any failure, however, of foot valve when pump is standing idle, will permit the pump to lose its prime. During long idle periods, the pump can also lose its prime through leakage from stuffing boxes.

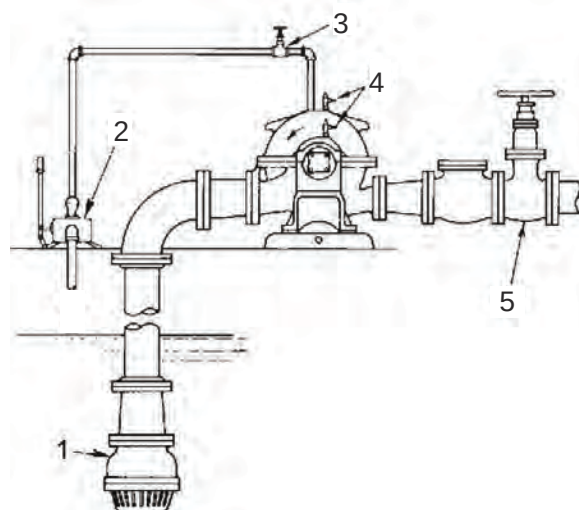
- a) Outside Supply: Close discharge gate valve, open air vent valves and open valve in priming supply line until all air is expelled and water issues from vent openings. Close air vent valves, close valve in priming supply line, and start pump; then open discharge gate valve.



- | | |
|-----------------------------|-------------------------|
| 1. Foot valve | 4. Air vent valves |
| 2. From some outside supply | 5. Discharge gate valve |
| 3. Shut off valve | |

Figure 55: Foot valve

- b) By Separate Hand, or Manually Controlled, Priming Pump: Close discharge gate valve (keep air vent valves dosed) and open valve in line to priming pump. Exhaust air from pump and suction piping until water flows from priming pump. With priming pump running, close valve in priming line, start pump and open discharge gate valve. An alternate method is to reverse connections on priming pump and extending priming pump suction to source of liquid supply. The pump may be primed by pumping liquid into casing until liquid comes out of the open air vent valves.

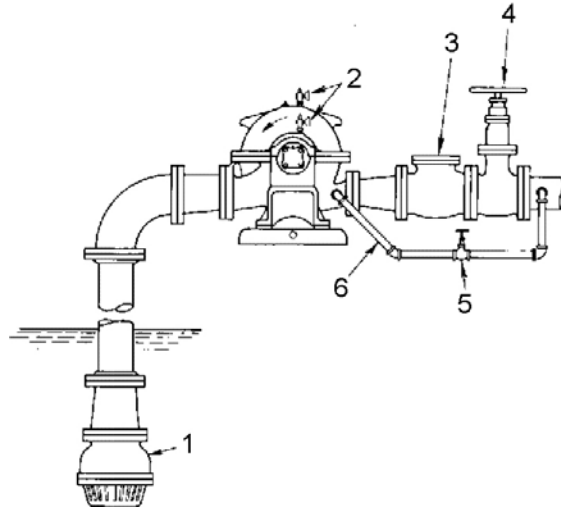


- | | |
|-------------------|--------------------|
| 1. Foot valve | 4. Air vent valves |
| 2. Priming pump | 5. Discharge valve |
| 3. Shut off valve | |

Figure 56: Hand or manually controlled pump

In methods a and b above, the pump will remain primed, provided foot valve is tight. Any failure, however, of foot valve when pump is standing idle, will permit the pump to lose its prime. During long idle periods, the pump can also lose its prime through leakage from stuffing boxes.

- c) **Bypassing Around Discharge Check Valve:** This method can be used only when there is liquid under some pressure in the discharge line. The original prime must be effected from some outside source. After subsequent idle periods, open air vent valves and open valve in bypass line around discharge check and gate valves until liquid flows from air vent openings. Close air vent valves and bypass valve, start pump and open discharge gate valve.

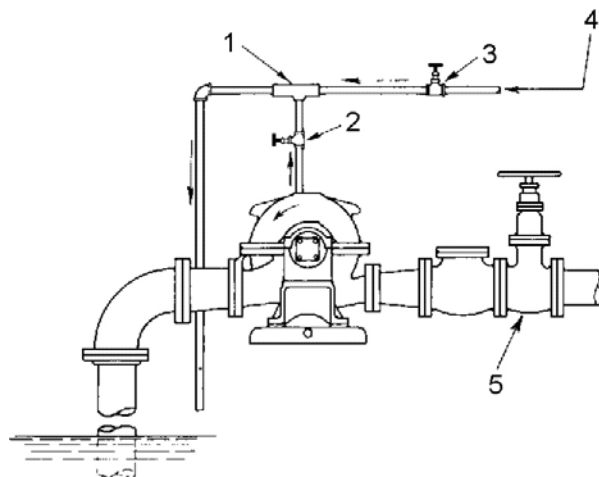


- | | |
|--------------------------|-------------------------|
| 1. Foot valve | 4. Discharge gate valve |
| 2. Air vent valves | 5. Shut off valve |
| 3. Discharge check valve | 6. By-pass line |

Figure 57: Bypassing

The valve in bypass can be left open, in which event, during idle periods, loss through foot valve is constantly replenished from discharge line. This system is used for automatic operation where idle periods are of short duration and there is no danger of exhausting all liquid from discharge line, due to a leaky foot valve. The foot valve must be capable of withstanding static head pressure of the system.

3. **Priming by Ejection**
 - a) On suction lift installation, an ejector, operated by steam, compressed air, or water under pressure, and connected to tapped opening in top of casing can be used to remove air from casing and suction line, thus priming the pump. See image below.



1 - Ejector

2 - Valve "S"

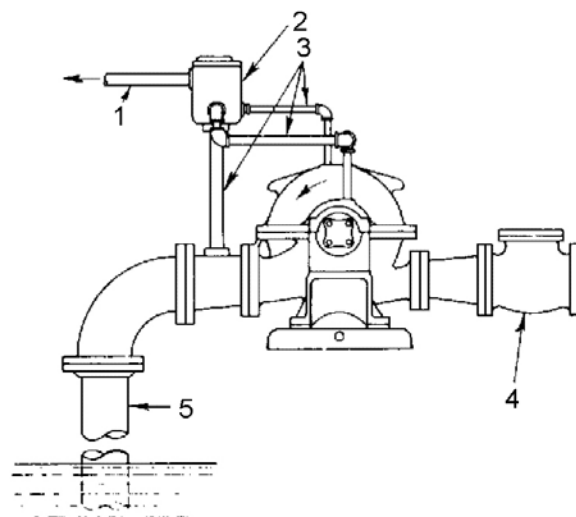
3 - Valve "E"

4 - Steam, compressed air, or water under pressure

5 - Discharge gate valve

Figure 58: Ejection

- b) Close discharge gate valve, open valve "E" in steam, air or water pressure supply line. Open valve "S" in suction pipe of ejector connected to pump casing. Air will be evacuated and liquid will be drawn up into suction pipe and pump casing. When all air is evacuated, start pump, close valve "S" and valve "E", and open discharge gate valve.
4. Priming by Automatic Primer Pump
- a) Where there is a fluctuating suction lift that occasionally might drop below the normal limits of the pump, or for installations where there is any quantity of air entrained in the pumpage, the system shown below is very well adapted.



1 - To primer pump

2 - Priming valve

3 - These lines must slope upward from pump to eliminate pockets

4 - Discharge check valve

5 - Suction pipe

Figure 59: Automatic primer pump

- b) A vacuum tank and a vacuum gauge can be installed near the primer pump and the vacuum switch set to automatically start or stop the primer pump according to the vacuum required to keep the system primed.

5.16 Start the pump



WARNING:

- Risk of equipment damage, seal failure and breach of containment. Ensure all flush and cooling systems are operating correctly prior to starting pump.
 -
-

NOTICE:

- Risk of equipment damage due to dry operation. Immediately observe the pressure gauges. If discharge pressure is not quickly attained, stop the driver immediately, reprime, and attempt to restart the pump.
 - To avoid risk of equipment damage, observe the pump for vibration levels, bearing temperature, and excessive noise. If normal levels are exceeded, shut down the pump and resolve the issue.
-

1. Fully close the discharge valve, depending on system conditions.
2. Start the driver.
3. Slowly open the discharge valve until the pump reaches the desired flow.
4. Immediately check the pressure gauge to ensure that the pump quickly reaches the correct discharge pressure.
5. If the pump fails to reach the correct pressure, perform these steps:
 - a) Stop the driver.
 - b) Restart the driver.
6. Monitor the pump while it is operating:
 - a) Check the pump for bearing temperature, excessive vibration, and noise.
 - b) If the pump exceeds normal levels, then shut down the pump immediately and correct the problem.
7. Repeat steps 5 and 6 until the pump runs properly.

5.17 Activate the i-ALERT® Health Monitor



WARNING:

Explosive hazard and risk of personal injury. Heating to high temperatures could cause combustion of the condition monitor. Never heat the condition monitor to temperatures in excess of 149°C | 300°F or dispose of in a fire.

By using the i-ALERT® Health monitor or the i-ALERT®2 Bluetooth Equipment Health Monitor, you agree to be bound by the Terms and Conditions of the [3.2 General description i-ALERT® Equipment Condition Monitor on page 15](#)

The health monitor is ready for activation when the pump is running and has reached a steady flow, pressure, and temperature. This process only takes a few minutes.

1. Place a small magnet on the health monitor over the ITT logo and then remove it, as this example shows.

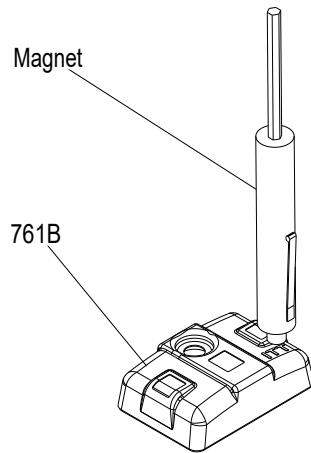


Figure 60: i-ALERT® Health monitor activation

When the condition monitor is activated it:

1. Displays a series of red LEDs followed by a solid green LED.
2. Collects eight samples that are spaced one second apart.
3. Averages these readings to establish the baseline vibration level.
4. Flashes a green LED after approximately twelve seconds.

For the first ten minutes, the green LED flashes every second for five consecutive flashes and then pauses to take a vibration reading. More frequent measurements (every six seconds) are taken in this startup period so that an alarm can be immediately detected.

5.18 i-ALERT® Equipment Health Monitor



WARNING:

Explosive hazard and risk of personal injury. Heating to high temperatures could cause combustion of the condition monitor. Never heat the condition monitor to temperatures in excess of 149°C | 300°F or dispose of in a fire.

For all information refer to the i-ALERT® Equipment Health Monitor Installation, Operation and Maintenance manual. <https://www.i-alert.com/support/>

5.19 Pump operation precautions

General considerations



WARNING:

- Risk of serious personal injury or property damage. Dry running may cause rotating parts within the pump to seize to non-moving parts. Do not run dry.

- Risk of explosion and serious physical injury. Do not operate pump with blocked system piping or with suction or discharge valves closed. This can result in rapid heating and vaporization of pumpage.
-

NOTICE:

- Risk of equipment damage from unexpected heat generation. Do not overload the driver. Ensure that the pump operating conditions are suitable for the driver. The driver can overload in these circumstances:
 - The specific gravity or viscosity of the fluid is greater than expected
 - The pumped fluid exceeds the rated flow rate.
 - Make sure to operate the pump at or near the rated conditions. Failure to do so can result in pump damage from cavitation or recirculation.
-

Operation at reduced capacity



WARNING:

- Risk of breach of containment and equipment damage. Excessive vibration levels can cause damage to bearings, stuffing box, seal chamber, and/or mechanical seal. Observe pump for vibration levels, bearing temperature, and excessive noise. If normal levels are exceeded, shut down and resolve.
 - Risk of explosion and serious physical injury. Do not operate pump with blocked system piping or with suction or discharge valves closed. This can result in rapid heating and vaporization of pumpage.
 - Risk of equipment damage and serious physical injury. Heat build-up can cause rotating parts to score or seize. Observe pump for excessive heat build-up. If normal levels are exceeded, shut down and resolve.
-

NOTICE:

- Cavitation can cause damage to the internal surfaces of the pump. Ensure net positive suction head available (NPSH_A) always exceeds NPSH required (NPSH₃) as shown on the published performance curve of the pump.
 -
-

Operation under freezing conditions

NOTICE:

Do not expose an idle pump to freezing conditions. Drain all liquid that will freeze that is inside the pump and any auxiliary equipment. Failure to do so can cause liquid to freeze and damage the pump. Note that different liquids freeze at different temperatures. Some pump designs do not drain completely and may require flushing with a liquid that doesn't freeze.

5.20 Initial Inspection After Starting

Packed Box

With pump running at rated speed, the stuffing box gland can be adjusted. Draw gland nuts up evenly and only 1/6 of a turn at a time, allowing sufficient time between adjustments for the packing to adjust

itself and the effect on the leakage to be observed. If any sign of heating is evident, shut down the pump and allow the box to cool. Several starts may be necessary before the box runs cool. Do not back off the gland nuts on a hot box as this will usually result in liquid leaking between the outer edge of the packing and the stuffing box bore. Remember that it takes newly installed packing some time to "run in" and that during this period, frequent attention and careful adjustments are necessary. See [5.23 Stuffing Box Operation on page 56](#).

Mechanical Seal

The mechanical seal was adjusted at the factory. If the seal leaks slightly when pump is first started, a few hours run-in will allow seal to adjust itself. Never run seal dry. Make sure cooling flow lines, if any, are operating properly.

5.21 Final Alignment



WARNING:

- Misalignment can cause decreased performance, equipment damage, and even catastrophic failure of frame-mounted units leading to serious injury. Proper alignment is the responsibility of the installer and the user of the unit. Check the alignment of all drive components prior to operating the unit.
 - Follow the coupling installation and operation procedures from the coupling manufacturer.
- Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
 - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
 - Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.

1. Final adjustment can only be accomplished after the unit has been run under actual operating conditions for a sufficient length of time to bring the unit up to operating temperature.
2. After this warm-up period has elapsed, stop the unit and immediately disconnect the coupling and check the alignment.
 - a) On "Back-Pull Out" end suction units, the frame foot should be loosened to relieve any strain due to thermal expansion.
 - b) On units which have jacking bolts on the foot, loosen the hold-down bolts.
 - c) On units which have a slotted hole on the foot near the bearing frame, loosen the foot-to-bearing frame bolt.
3. Make sure motor switch is "locked out" to prevent accidental rotation. After a minute or two, retighten foot bolts.
4. Repeat each alignment procedure outlined in [4.5.1 General Alignment Procedures on page 23](#).
5. Reconnect coupling.
6. Check final alignment after approximately one week of operation.

5.22 Doweling

Some units do not require doweling since lock washers are furnished which hold the pump and driver feet securely in place. On other units, the pump and driver feet should be doweled after installation is

completed, and the unit is in correct final alignment. Taper dowel pins, included in the box of fittings, are furnished for these units.

NOTICE:

On all multi-stage units, dowel pins (if supplied) should be used on the coupling end of pump only. Do not dowel feet on outboard end of pump.

1. On units to be doweled (except those noted above), drill through two diagonally opposite feet of the pump into the bedplate.
Use a reamer with a $\frac{1}{4}$ " per foot taper. The dowels should extend well into the bedplate but project above the pump feet.
2. Drivers should also be doweled but the driver manufacturer should be contacted for instructions.

5.23 Stuffing Box Operation

**WARNING:**

Packed stuffing boxes are not allowed in an Ex-classified environment.

1. Stuffing boxes with packing rings - less quenching liquid or grease lubricator:
 1. Periodically inspect stuffing box to see that there is sufficient leakage to lubricate the packing and maintain a cool box. Never draw up packing so that the stuffing box heats, as this will cause damage to both packing and sleeve. Draw up gland nuts slowly and evenly and only when pump is running.
 2. After pump has been in operation for some time and the packing has been completely run in, at least 40 to 60 drops per minute of the liquid should be allowed to trickle from the stuffing box at all times for cooling and lubricating the packing and shaft sleeve.
2. Stuffing boxes with packing rings-with quenching liquid:
 1. The same precautions as described above apply. However, the amount of leakage through the packing cannot be easily determined, due to the quenching liquid. In most cases, the valve on the quenching liquid supply line can be shut off for a short period and the amount of leakage determined as in step 1 above.
 2. In no instance should the gland be drawn up tight. Never throttle the clean liquid supply into the stuffing box as a substitute for proper adjustment of packing - a steady flow from the seal cage into the pump is required to prevent entrance of pumpage into the packing.
3. Stuffing boxes with packing rings - with grease lubricator:
 1. Operation is the same as directed in step 1 above, with the addition that the handle on the lubricator should be given a turn or two about every 100 hours of operation.
4. Stuffing boxes with mechanical seal:
 1. This type of box requires no attention other than to make sure that the circulating lines do not become clogged.

5.24 Operating at Reduced Capacities

Do not operate a centrifugal pump at greatly reduced capacities or with discharge gate valve closed, because the energy required to drive the pump is converted into heat. The temperature of the liquid in the

pump may increase until the boiling point is reached. If this occurs, the rotating parts are exposed to vapor with no lubrication and they may score or even seize to the stationary parts.

NOTICE:

If running clearances have enlarged due to wear, seizure may not take place and continued operation under these conditions may create an explosive hazard due to the confined vapor under high pressure and temperature.

To guard against possible damage, protective devices are available, such as:

1. Liquid temperature relay or thermostat which will shut off the unit if the liquid temperature in the pump exceeds a predetermined maximum. This device guards against possible damage due to running the pump against a closed valve.
2. Constant open by-pass orifice between the pump discharge and any check or regulating valve in the discharge line. The liquid through the orifice is returned to the suction source. The amount of liquid bypassed is a function of input horsepower and the allowable temperature rise. This device also is insurance against damage due to running the pump against a closed discharge valve or very low flow conditions.
3. Bearing temperature relay which will shut the unit down if the bearing temperature exceeds a predetermined maximum.
4. Low suction pressure control which will shut off the unit should the suction pressure drop below a pre-established minimum. A centrifugal pump should never be throttled for capacity adjustment on the suction side.

5.25 Operating at Reduced Head

On motor driven pumps, when discharge head or pressure is allowed to drop considerably below the rated point for any length of time, the motor should be watched for heating because the pump capacity increases with reduced head, as does horsepower consumption. If this condition is likely to persist, arrangements should be made either to manually or automatically throttle the discharge valve to build up head to a safe point.

5.26 Operating with Surge Conditions in Line

If a pump is installed with a quick closing valve in discharge line that closes when pump is running, dangerous pressure surges may be built up that can cause damage to the pump or line. In services of this kind, some cushioning arrangement must be provided to protect the pumping equipment.

5.27 Operating under Freezing Conditions

When exposed to freezing conditions and pump is standing idle, liquid inside the pump should be drained by removing drain plugs in bottom of casing and opening air cocks at top. Liquid inside cooling jackets or glands should also be drained.

5.28 Deactivate the i-ALERT[®] Equipment Health Monitor

NOTICE:

Always deactivate the health monitor when the pump is going to be shut down for an extended period of time. Failure to do so will result in reduced battery life.

1. Touch and hold a small magnet to the health monitor over the ITT logo until the red LEDs blink three times.
This should take 10-15 seconds if the health monitor is in normal operating mode and approximately five seconds if the condition monitor is in alarm mode.
2. Remove the magnet.

If the deactivation is successful, solid red LEDs will be displayed.

5.29 Reset the i-ALERT® Health Monitor

To deactivate or reset the i-ALERT® monitor, please refer to the i-ALERT® IOM, <http://i-alert.com/>

Always reset the health monitor when the pump is started after maintenance, system change, or being shut down for an extended period of time. Failure to do so may result in false baseline levels that could cause the health monitor to alert in error.

6 Maintenance

6.1 Bearing Maintenance



tion.

For Ex applications bearing replacement (all) is recommended after 25,000 hours of operation.

6.1.1 Bearing Temperatures



WARNING:



These bearing lubrication sections list different temperatures of the pumped fluid. If the pump is Ex-certified and the temperature of the pumped fluid exceeds the permitted temperature values, then consult your ITT representative.

All bearings operate at some temperature above that of the surrounding atmosphere, unless cooled. Heat is generated within the bearing due to rolling friction, churning of oil and the "drag" of the race.

Do not use the human hand as a thermometer. A temperature which feels "hot" varies from 49°C to 53°C | 120° F - 130°F, depending upon the individual. Above this temperature, the human hand is worthless in estimating temperature.

Bearing temperatures up to 82°C | 180°F are normal. Determine the temperature accurately by placing a contact type thermometer against the bearing housing. It should be recorded in a convenient location for reference. The stability of the temperature, rather than the number of degrees is the best indication of normal operation. A sudden increase in temperature is an indication of danger and a sign al to investigate. The unit should be checked for abnormal hydraulic operation and unnecessary loads, such as coupling misalignment, etc.

6.1.2 Bearing Inspection

- Ball and Roller Bearings

Ball and roller bearings can be checked for visible wear by slowly turning the races and watching for pits or worn areas on the balls, rollers or raceways. The bearings can also be inspected by holding the inner race and spinning the outer race. If any rasping noises are emitted or the bearing "catches", it should be replaced. If any wear on the races is apparent, replacement is suggested.

- Sleeve Bearing

Sleeve bearings should be inspected to determine if any deep scratches or gouges (other than oil grooves) are present. The babbitted surfaes should also be free of high or low spots. Unless these surfaces are completely smooth, they should be replaced if they cannot be "scraped in."

6.1.3 Clean the Bearings

The life of a bearing can be drastically reduced if contaminated with even a small amount of dust or dirt. All bearing assembly operations should be done in as dust-free an atmosphere as possible. All tools, as well as the hands, should be kept clean.

1. If new bearings are to be installed, they should not be unwrapped until ready for installation and should not be cleaned or washed.
2. If old bearings are dirty, they should be replaced. Washing the bearings does not guarantee cleanliness and is risky at best. If new bearings are not readily available, and immediate reassembly is necessary, dirty bearings can be cleaned as follows:
 - a) Pour one or two quarts of clean, water-free kerosene into a clean pail.
 - b) Dip the bearings into the kerosene and agitate slowly.
 - c) Repeat until bearing is completely clean.
 - d) Blow dry with clean filtered compressed air.
 - e) With ball bearings, hold the two races together, but allow the inner race to rotate a few turns now and then to dislodge the kerosene from the retainer pockets.
 - f) When the bearing has been blown dry, oil it immediately with a good grade of clean machine oil to prevent corrosion or rust.
3. If there is any question as to the condition of bearings, it is always best to replace them. This may prevent an unplanned shutdown.

6.1.4 Bearing Removal



CAUTION:

Risk of physical injury from hot bearings. Wear insulated gloves when using a bearing heater.

1. Ball Bearings
 - a) A puller such as the one shown below should be used. The puller bar must be "square" with the end of the shaft at all times in order to keep even pressure on the outer circumference of the bearing.

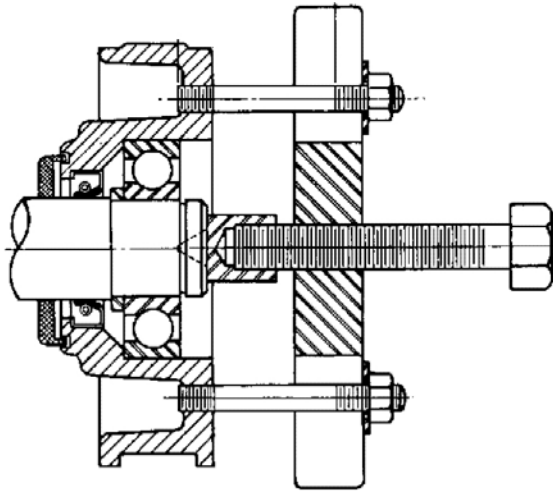


Figure 61: Bearing puller

- b) The puller screw should be tightened steadily to enable the bearing to slide smoothly off the shaft.

On some units, the bearing housings slide off the bearings and the puller such as the one shown below should be used. This type of puller pulls directly against the bearing itself. The puller bar must be "square" with the end of the shaft at all times and the puller screw should be tightened steadily to enable the bearings to slide smoothly off the shaft.

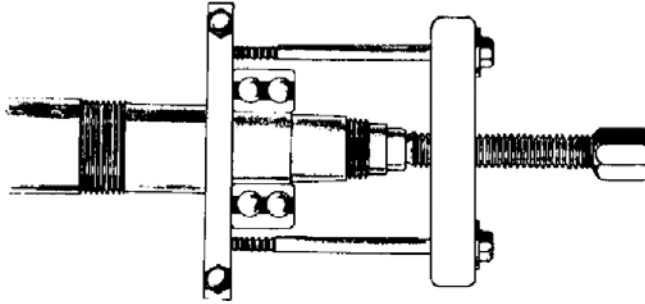


Figure 62: Bearing puller

NOTICE:

Do not damage the end of the shaft.

2. Sleeve Bearings
 - a) After the bearing shells have been removed, a bearing puller, such as shown above should be used to remove the ball bearing.
 - b) The puller bar must be "square" with the end of the shaft at all times and the puller screw should be tightened steadily to enable the bearing to slide smoothly off the shaft. Do not damage the end of the shaft.
3. After the bearings have been removed, they should be wrapped in dean paper or cloth to prevent contamination. Other parts which surround the bearings, such as bearing housings, should be kept clean in the same manner.

6.1.5 Install the Ball Bearings

NOTICE:

There are several methods used to install bearings. The recommended method is to use an induction heater that heats as well as demagnetizes the bearings. Failure to use this method may result in equipment damage.

1. A film of clean machine oil should be applied to the bearing seat on the shaft.
2. The bearing should be started on the shaft by tapping the inner race with a hammer or mallet. Do not use a lead mall. The bearing must be kept "square" at all times.
3. Once the bearing is located on the shaft, a driving sleeve, such as the one shown below should be used. The sleeve should contact the inner race of the bearing only. The bearing should be pressed or driven until it contacts shoulder "x".

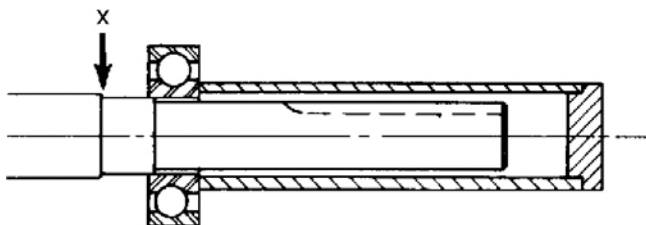


Figure 63: Driving sleeve

4. Duplex thrust bearings must be mounted in the proper position as described in [6.8 Reassemble the Pump on page 74](#).

6.2 Lubricate the Pump



WARNING:



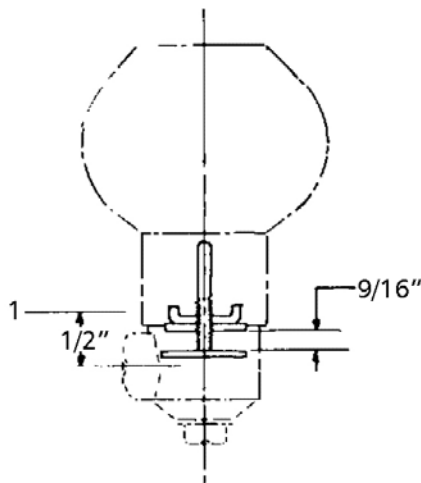
Risk of explosive hazard and premature failure from sparks and heat generation. Ensure bearings are properly lubricated prior to startup.

1. Oil Lubrication

Refer to [5.2 Pump Bearings on page 40](#) for oil specifications. Oil lubricated ball bearings are standard on the Model 3175. The bearings are not lubricated at the factory.

Oil lubricated pumps are supplied with an oiler which maintains a constant oil level in the bearing frame. Refer to [6.5 Disassemble the Pump on page 67](#) for oiler location.

- a) Before installing the oiler on the bearing frame, check the oiler adjustment.



1 - Oil level

Figure 64: Oiler

Instructions

- i. Remove adjustment assembly from oiler
 - ii. Adjust bars to 9/16"
 - iii. Lock in position
 - iv. Replace adjustment assembly in oiler
- b) Install oiler on either side near oil level groove marked on frame.
 - c) Fill the oiler bottle with oil and replace in the oiler housing. Oil reservoir in bearing frame is filled when oil remains visible in the bottle. Several fillings of the bottle will be required. Never fill through the oil vent or the oiler without use of the bottle.

For information only: The Model 3175 bearing frame oil capacities are:

Group	Approx. Capacity
S	167 oz 5 Qts.
M	133 oz 4 Qts.
L	100 oz 3 Qts.

2. Grease Lubrication - To lubricate pump: Insert grease through grease fittings while shaft is rotating, until clean grease appears through the relief caps.

Refer to [5.2 Pump Bearings on page 40](#) for grease specifications. Grease lubrication is optional on the Model 3175. These units can be identified by the grease fitting located on the bearing housing. Bearings are lubricated at the factory. Do not grease at too frequent intervals.

To lubricate pump: Insert grease through grease fittings while shaft is rotating, until clean grease appears through the relief caps.

NOTICE:

Risk of equipment damage. Ensure that the grease container, the greasing device, and the fittings are clean. Failure to do so can result in impurities entering the bearing housing while regreasing the bearings.

3. Conversion From Oil to Greased Lubrication

NOTICE:

- Grease can settle in equipment left idle leaving bearings improperly lubricated. Check the greasing on a pump that has been out of service for a long period of time and re-grease if necessary.
 - Avoid equipment damage or decreased performance. Never mix greases of different consistencies (NLGI 1 or 3 with NLGI 2) or with different thickeners. For example, never mix a lithium-based grease with a polyurea based grease. If it is necessary to change the grease type or consistency, remove the rotor and old grease from the housing before regreasing.
-

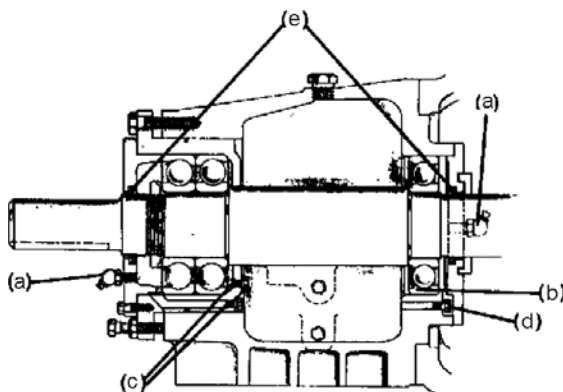


Figure 65: Grease lubricated bearings

- a) For oil lubrication, both bearing end covers (inboard and outboard) are equipped with two 1/8" taps that are plugged. To convert to grease lube, 1/8" Alemite fittings are installed in place of these plugs.
- b) Radial bearings are changed to have a shield on the frame reservoir side of the balls. The following are correct designations:

Frame	MRC Bearing No.
S	313 SF
M	317 MF
L	222 MF

- c) The bearing housing should have three 3.175mm [1/8"] recirculation openings plugged.
- d) Bearing frame should have one recirculation opening at the radial bearing plugged.

- e) Position of oil seals remain unchanged with lips facing away from bearings.

6.3 Impeller Clearance Adjustment



WARNING:

Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.

- Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
- Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.



The impeller clearance setting procedure must be followed. Improperly setting the clearance or not following any of the proper procedures can result in sparks, unexpected heat generation, and equipment damage.

If a gradual loss in head and/or capacity occurs, performance can be restored by adjusting the impeller. If performance cannot be restored by adjustment, pump should be disassembled as directed in [6.5 Disassemble the Pump on page 67](#) and the impeller and casing inspected for wear.

Either a feeler gauge or a dial indicator can be used to set the impeller clearance.

Feeler Gauge Method

1. Loosen adjustment bolts and nuts (371A & 423B).
2. Tighten bolts (370C) evenly, while slowly rotating the shaft, until the impeller just starts to rub on the casing.
3. Loosen each bolt (370C) until a 0.38 mm | .015" feeler gauge can be placed between the bearing housing flange and underside of head of bolts (370C).
4. Be sure that jam nuts on bolts (371A & 423B) are loose. Tighten each bolt (371A & 423B) a flat at a time until bearing housing is tight against bolts (370C). Be sure that all bolts (370C, 371A & 423B) are tight. Tighten jam nuts on bolts (371A & 423B).

A - Feeler Gauge

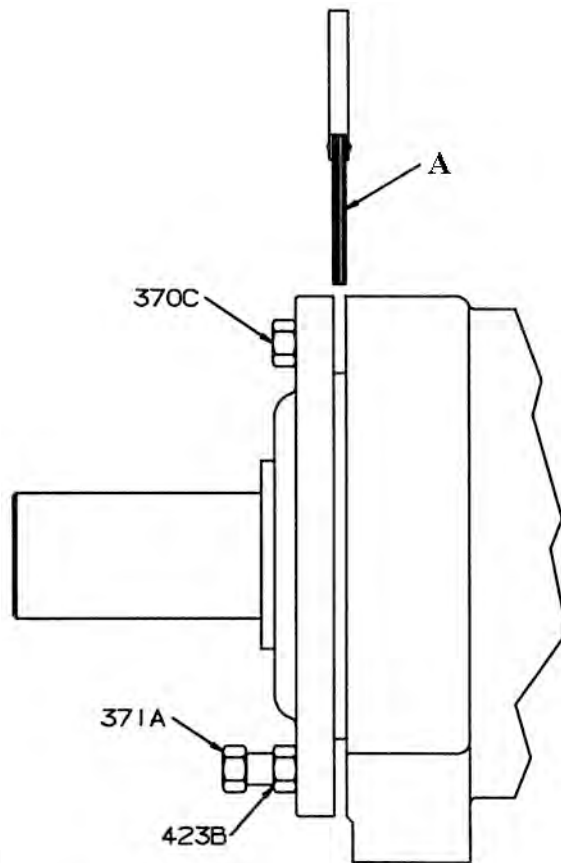


Figure 66: Feeler Gauge Method

Dial Indicator Method

1. Remove one bolt (370C) and thread a pipe or rod in its place. This is to hold a dial indicator as shown below.
2. Loosen adjustment bolts and nuts (371A & 423B).
3. Tighten each bolt (370C) evenly, while slowly rotating the shaft, until impeller just starts to rub against casing.
4. Clamp a dial indicator so that the button rests against the end of the shaft, or against the front of the face of the coupling, and set indicator at zero.
5. Loosen bolts (370C) about 6 flats.
6. Be sure that jam nuts on the bolts (371A & 423B) are loose. Tighten bolts (371A & 423B) a flat at a time, until the dial indicator shows that the shaft has moved 0.38mm | 0.015".
7. Tighten bolts (370C), then check to be sure all bolts (371A & 423B) are tight. Finally, tighten jam nuts on bolts (371A & 423B).

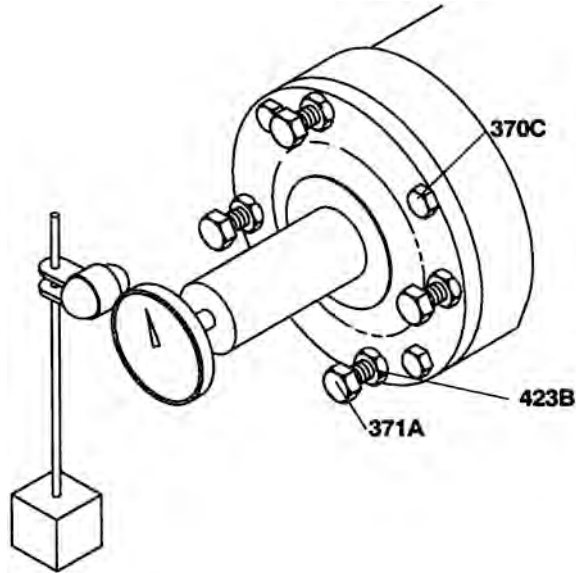


Figure 67: Dial Indicator Method

When either of the above methods, the rotating element and impeller have been moved 0.20mm to 0.38mm | 0.008" to 0.015" away from the casing, thus giving the required clearance between these two parts. Rotate shaft several times to check for free turning.

6.4 Disassembly precautions



WARNING:

- Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
 - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
 - Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.
- Risk of serious personal injury. Applying heat to impellers, propellers, or their retaining devices can cause trapped liquid to rapidly expand and result in a violent explosion. This manual clearly identifies accepted methods for disassembling units. These methods must be adhered to. Never apply heat to aid in their removal unless explicitly stated in this manual.
- Handling heavy equipment poses a crush hazard. Use caution during handling and wear appropriate Personal Protective Equipment (PPE, such as steel-toed shoes, gloves, etc.) at all times.
- Precautions must be taken to prevent physical injury. The pump may handle hazardous and/or toxic fluids. Proper personal protective equipment should be worn. Pumpage must be handled and disposed of in conformance with applicable environmental regulations.
- Risk of serious physical injury or death from rapid depressurization. Ensure pump is isolated from system and pressure is relieved before disassembling pump, removing plugs, opening vent or drain valves, or disconnecting piping.
- Risk of serious personal injury from exposure to hazardous or toxic liquids. A small amount of liquid will be present in certain areas like the seal chamber upon disassembly.

**CAUTION:**

- Avoid injury. Worn pump components can have sharp edges. Wear appropriate gloves while handling these parts.

6.5 Disassemble the Pump

**WARNING:**

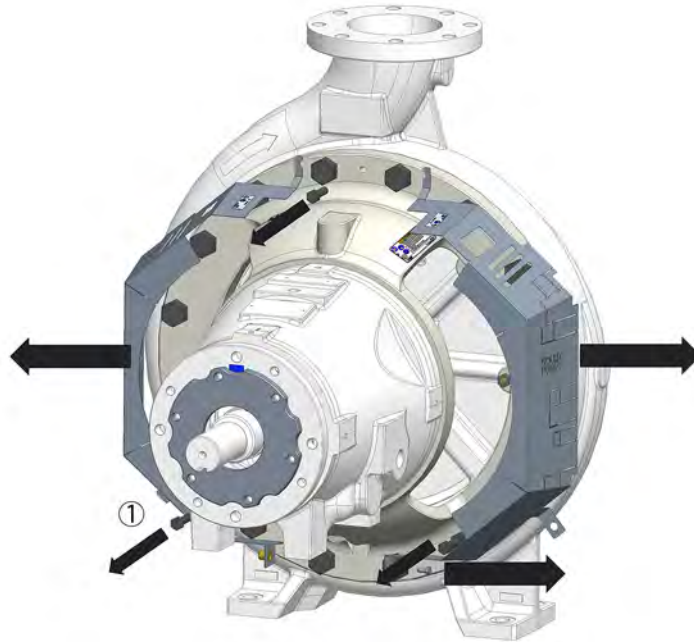
- Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.
 - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
 - Refer to driver/coupling manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.
- Lifting and handling heavy equipment or components poses a crush hazard. Use caution during lifting and handling and wear appropriate Personal Protective Equipment (PPE, such as steel-toed shoes, gloves, etc.) at all times. Seek assistance if necessary.
- Risk of severe physical injury or death from explosion of trapped liquid. Never use heat to remove parts unless explicitly stated in this manual.

The back pull-out feature of this pump allows the complete back pull-out assembly (bearing frame and rotating element) to be removed without disturbing suction or discharge piping or driver.

The [8.3 Parts List on page 86](#) contains a complete sectional view of the pump and parts list with the proper identification numbers. Refer to this section as required during maintenance procedures and when ordering spare or repair parts.

To prepare pump for disassembly, proceed as follows:

1. Lock out power supply to motor.
2. Shut off all valves controlling flow to and from the pump.
3. Drain liquid from pump. Remove casing drain plug (if supplied) which is located on bottom of casing at lowest point.
4. Remove all auxiliary tubing and piping.
5. Flush the pump to remove corrosive or toxic pumpage if required.
6. Disconnect coupling and remove coupling spacer (refer to coupling instructions).
7. Drain oil (remove drain plug) and remove bottle oiler.
8. Remove the shaft guard, if provided.
 - Do not remove the clip that retains the bolt on the guard to maintain a captive fastener.
 - Retain each guard half with fasteners for reinstallation.



Item	Description
1.	Mounting bolt

Figure 68: Remove the shaft guard - if provided

9. If unit has stuffing box packing, remove the gland stud nuts. The gland is in two halves and can be removed.

The numbers located on the following figures refer to the procedure steps. For example, number 1 on Figure 5A refers to Step 1.

1. Place chain or sling from crane or hoist through eye bolt.

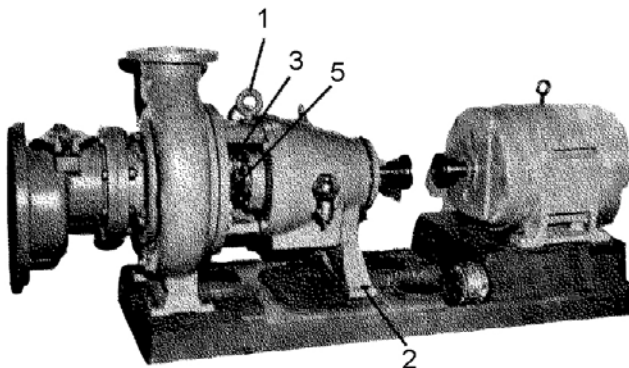


Figure 69: Disassembly

2. Remove frame foot hold-down bolts.
 3. Remove bolts which hold frame adapter to casing.
 4. Adjust sling tension to support back pull-out assembly.
 5. Slide the back pull-out assembly from the casing. The Model 3175 has jacking bolts to assist disassembly. Screw the jacking bolts into the tapped holes in the frame adapter. Tighten bolts evenly, a flat at a time, to jack back pull-out assembly from casing.
- If working space is available to the side of the bedplate, the "pull-out assembly" can be turned perpendicular to the bedplate. Replace one pedestal hold-down bolt in bedplate and support the bearing frame flange with blocks. Complete disassembly of the "pull-out" assembly can be accomplished on the job site. If preferred, it can be removed to an available work area.

6. Remove casing gasket.

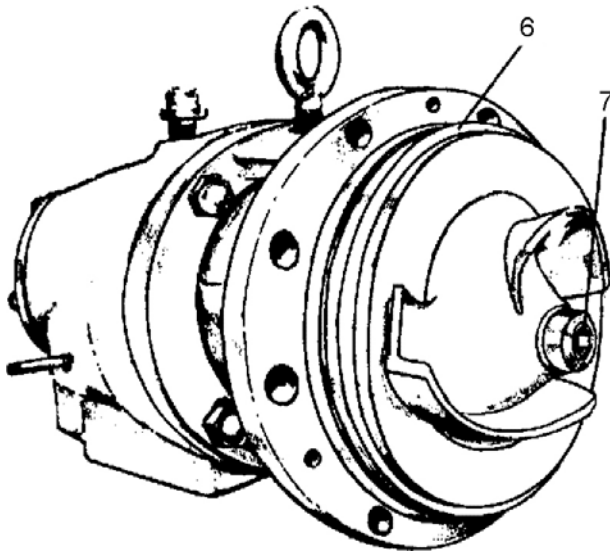
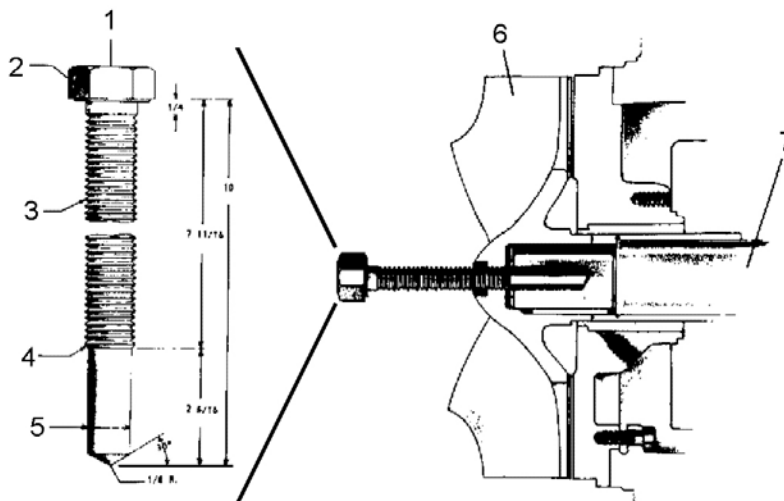


Figure 70: Pull-out assembly

7. Remove the impeller screw with 3/4" Allen wrench. Prevent the shaft from rotating by using a wrench on coupling "flats". Do not lose or damage the impeller screw O-ring.



1. Impeller puller stud - Mach. from std 1" H.H.M bolt
2. 1-1/2 width across flats
3. 1"11/12 R.H. threads
4. 1/16 x 45° chamfer

5. 13/16 ± 0 to 1/32
6. Impeller
7. Shaft

Figure 71: Impeller Puller Stud

Thread the impeller puller stud into the end of the impeller. This stud pushes against the shaft and pulls the impeller as the stud is turned clockwise.

8. Remove impeller key from the shaft.
Do not lose or damage the shaft sleeve O-ring which seals between the impeller and sleeve.

**CAUTION:**

Risk of physical injury from sharp edges. Wear heavy work gloves when handling impellers.

9. If unit has mechanical seal, remove gland stud nuts. The gland is a solid ring and cannot be removed after unbolting. Carefully slide the gland off the gland studs and move back on shaft and shaft sleeve. Avoid contact with exposed lapped seal faces and keep them clean.

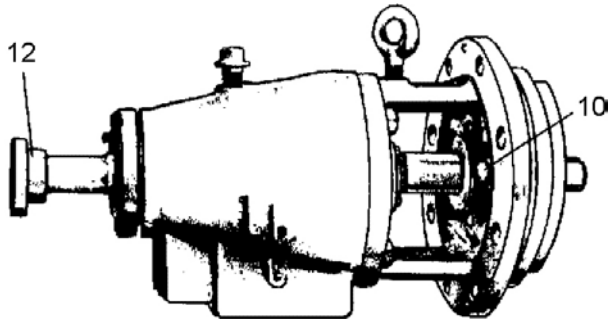


Figure 72: Removal of gland stud nuts and gland

10. Remove the adapter to stuffing box bolts. Pull the stuffing box cover from the frame adapter. (On some units, specifically the 18 and 22 inch units, tapped holes are provided in the frame adapter for the use of jacking bolts to assist disassembly of the stuffing box cover). Do not allow the stuffing box cover to strike the shaft, shaft sleeve, or any mechanical seal part.
11.
 - a) If the pump has a packed stuffing box, remove packing and lantern ring from the stuffing box cover.
 - b) If the pump has a mechanical seal, the rotary portion of seal will slide off with the sleeve. Do not damage seal faces.
12. Scribe shaft at coupling hub for proper positioning of hub during reassembly and remove hub. To disassemble remainder of the liquid end; casing, suction sideplate, and suction piece (if supplied), proceed as follows:
13. Disconnect suction and discharge flanges.
14. Remove casing hold-down bolts and move casing toward driver. If preferred, casing can be removed from bedplate for further disassembly.
15. Remove suction sideplate nuts.

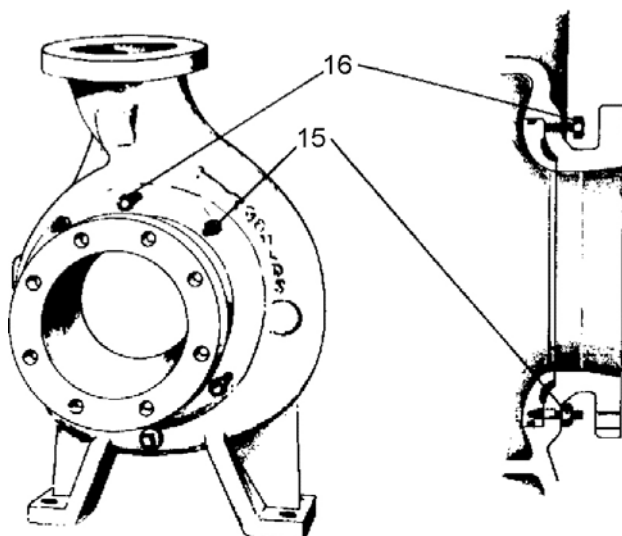


Figure 73: Liquid end disassembly

16. Remove the suction sideplate by tightening the jacking screws evenly. Be sure not to damage the sideplate O-ring. Remove the sideplate-to-casing gasket.
To complete disassembly of the power end, proceed as follows:
17. Remove the bolts which hold the frame adapter to the bearing frame. Remove the frame adapter.
18. Remove the deflector from the shaft.
19. Remove the bolts which hold the inboard bearing end cover to the frame. Remove the end cover.
Do not damage the oil seal.
20. Tap the oil seal from the inboard bearing end cover if replacement of seal is required. Refer to [6.7 Inspection and Overhaul on page 72](#) for replacement sizes.
21. Remove bearing housing bolts (2). Impeller adjustment bolts with jam nuts (1) can be used to assist in the removal of the shaft and bearing assembly from the bearing frame.

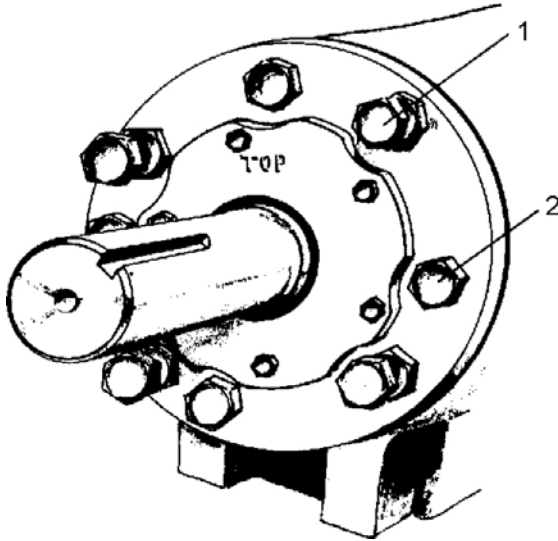


Figure 74: Bearing housing bolt removal

22. Slide the complete shaft assembly from back end of bearing frame. This includes the shaft, both bearings (radial and thrust), and bearing housing. Do not lose or damage bearing housing O-ring.

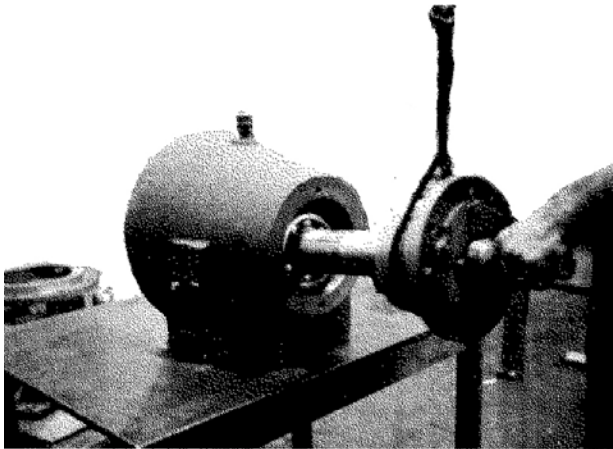


Figure 75: Shaft removal

23. Remove the inboard bearing using a bearing puller as shown in [6.1.4 Bearing Removal on page 60](#). Care must be taken to prevent damage to bearing. Never use a hammer to drive shaft through bearing. Protect bearing from contamination.
24. Remove the bolts which hold the bearing end cover to the bearing housing. Remove the bearing end cover. Be sure shaft is free of burrs so the oil seal will not be damaged.

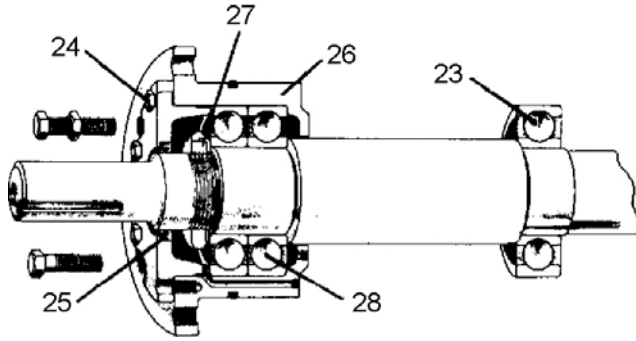


Figure 76: Bolt removal

25. Tap the oil seal from the coupling end bearing end cover if replacement of seal is required. Refer to [6.7 Inspection and Overhaul on page 72](#) for replacement sizes.
26. Slide the bearing housing off shaft.
27. Straighten "tang" in lock washer and remove bearing lock nut and washer.
28. Remove coupling end bearing using a bearing puller as shown in [6.1.4 Bearing Removal on page 60](#). Care must be taken to prevent damage to bearings. Never use a hammer to drive shaft through bearing. Protect bearing from contamination.

6.6 Guidelines for i-ALERT® Equipment Health Monitor disposal

Precautions



WARNING:

- Explosive hazard and risk of personal injury. Heating to high temperatures could cause combustion of the condition monitor. Never heat the condition monitor to temperatures in excess of 149°C | 300°F or dispose of in a fire.

Guidelines

The battery contained in the condition monitor does not contain enough lithium to qualify as reactive hazardous waste. Use these guidelines when disposing of the condition monitor.

- The condition monitor is safe for disposal in the normal municipal waste stream.
- Adhere to local laws when you dispose of the condition monitor.

6.7 Inspection and Overhaul

Impeller



WARNING:

- Risk of death or serious injury. Leaking fluid can cause fire and/or burns. Replace all gaskets and O-rings at each overhaul or disassembly.
- Risk of death or serious injury. Leaking fluid can cause fire and/or burns. Inspect and ensure gasket sealing surfaces are not damaged and repair or replace as necessary.
- Risk of serious personal injury or property damage. Fasteners such as bolts and nuts are critical to the safe and reliable operation of the product. Ensure appropriate use of fasteners during installation or reassembly of the unit.
 - Use fasteners of the proper size and material only.

- Replace all corroded fasteners.
- Ensure that all fasteners are properly tightened and that there are no missing fasteners.

**CAUTION:**

Risk of physical injury from sharp edges. Wear heavy work gloves when handling impellers.

Replace if impeller shows excessive erosion (especially on ejector vanes on back side of impeller), corrosion, extreme wear or vane breakage. O-ring groove and impeller hub must be in good condition. Impeller has a push fit on shaft 0.000mm to 0.038mm | 0.000" to 0.0015" loose. Check impeller balance.

Sideplate

To maintain maximum efficiency, the clearance between sideplate and impeller should be 0.038mm | 0.015". Overall travel in casing is between 1.499mm and 2.159mm | 0.059" and 0.085". Sideplates should be inspected for erosion, pitting or excessive wear. Replacement is required when distance between impeller and suction sideplate cannot be held to 0.038mm | 0.015" with the axial impeller adjustment.

Shaft

Check for runout to see that the shaft is not bent. Bearing seats and oil seal areas must be in perfect condition and free of scratches and grooves. O.D. and finish in these areas must be within bearing manufacturer's specifications. Check that the keyway is free of corrosion. Replace shaft if necessary.

Shaft Sleeve

The shaft sleeve is a push fit and is bored: "S"- 0.000mm to 0.051mm | 0.000" to 0.002"; "M" & "L" - 0.025mm to 0.076mm | 0.001" to 0.003" larger than the shaft and should tap easily on the shaft. If the sleeve does not tap on easily, the bore and shaft should be inspected to see that they are free from foreign matter or burrs. The fit of the key in the keyway should also be checked to see that it is not causing binding. The key should have a sliding fit on the sides and should have clearance at the top. Sleeve surface in stuffing box must be smooth and free of grooves. If grooved, replace. O-ring groove must be in good condition. The original diametric clearance between shaft sleeve and stuffing box bushing is 0.635mm to 0.813mm | 0.025" to 0.032". If this clearance has increased to more than 1.27mm | 0.050", the shaft sleeve, and at times, the stuffing box bushing should be replaced.

Mechanical Seal

Lapped seal faces, gaskets, and shaft sealing members must be in perfect condition or excessive leakage may result. Replace worn or damaged parts.

Ball Bearings

Replace if worn, loose, rough or noisy when rotated. If dirty, refer to [6.1.3 Clean the Bearings on page 59](#). Replacement bearings must be proper size and type as specified in the Construction Details in [8.3 Parts List on page 86](#). New bearings should not be unwrapped until ready for use.

Oil Seals

Inspect and replace if torn or otherwise damaged. The sizes are:

Table 8: Coupling end

Group	Vendor	Vendor Part No.
S	Crane	237-325-16

Group	Vendor	Vendor Part No.
M	Chicago Rawhide	31177
L	Crane	412-525-16

Table 9: Inboard

Group	Vendor	Vendor Part No.
S	Crane	250-325-12
M	Chicago Rawhide	33041
L	Garlock	53 X 2687

Seals are held by a press fit. Lips on seals should face out (away from bearings). One side of bored hole for oil seal is chamfered so that seal will start easily when pressed in.

General

NOTICE:

Protect machined surfaces while cleaning the parts. Failure to do so may result in equipment damage.

All parts should be clean before assembly. This is especially important at O-ring grooves, threads, lock fits, gasket surfaces, and bearing areas. Any burrs should be removed with crocus cloth.

6.8 Reassemble the Pump

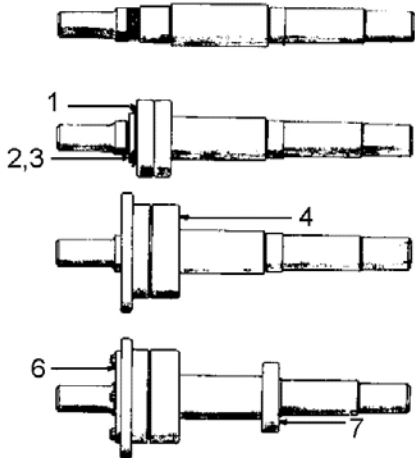
This procedure covers reassembly of the pump after complete disassembly. Be sure all directions in [6.7 Inspection and Overhaul on page 72](#) have been followed.



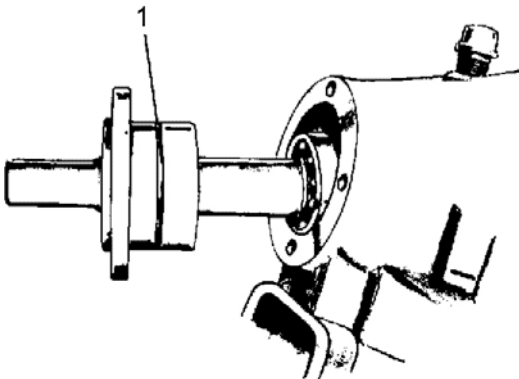
WARNING:

Lifting and handling heavy equipment poses a crush hazard. Use caution during lifting and handling and wear appropriate Personal Protective Equipment (PPE, such as steel-toed shoes, gloves, etc.) at all times. Seek assistance if necessary.

1. Oil bearing seat on coupling end of shaft. Slide coupling end bearing (duplex, mounted back to-back) on shaft as far as possible by hand. Place pipe or driving sleeve (such as the one shown in [6.1.5 Install the Ball Bearings on page 61](#)) over shaft, making sure it rests against inner race only. Make sure bearing is "square" on shaft. Tap or press evenly until bearing is seated firmly against the shaft shoulder. Do not mar the shaft, especially where it contacts oil seal. The duplex bearings supplied by the factory as standard are manufactured by MRC. If equivalent bearings of other manufacturer's are used, the arrangement will vary. The duplex bearing arrangement depends on the type of construction used by the manufacturer. Refer to the manufacturer's instructions packed with the bearings for duplex mounting arrangement.
2. Insert the bearing lock washer, pressing tang into shaft keyway until it is firmly against the bearing.
3. Oil shaft threads lightly and snug the bearing locknut against the lock washer. Tighten firmly with a spanner wrench. Seat tang securely into slot in locknut with drift pin. If necessary, tighten locknut slightly to match tang with slot. Do not loosen locknut to position.

**Figure 77: Pump reassembly**

4. Slide bearing housing with O-ring in place, over impeller end of shaft and over outboard bearing.
5. Tap outboard oil seal in place on bearing end cover (coupling end).
6. Place bearing end cover and 0.152mm | 0.006" white manila gasket over coupling end of shaft and fit into bearing housing. If oil seal is dry, oil lightly before sliding over shaft. Be sure to position "TOP" (cast on cover) in line with "TOP" on housing. Bolt end cover firmly to housing.
7. Oil inboard bearing seat on shaft. Slide inboard ball bearing on shaft as far as possible by hand. Place pipe or sleeve (such as the one shown in [6.1.5 Install the Ball Bearings on page 61](#)) over shaft, making sure bearing is "square" on shaft. Tap or press sleeve evenly until bearing is seated firmly against shaft shoulder. Do not mar shaft, especially where it contacts the oil seal or in stuffing box area.
8. Place a small amount of O-ring lubricant on inside of bearing frame at bearing housing and inboard bearing seats, on O-ring, and on inboard oil seal. Slide shaft assembly into the bearing frame as far as possible. When the bearing housing is properly installed (oil return hole at the bottom), the word "TOP" located on the flange of the bearing housing will line up with the top of bearing frame. Be sure bearing housing O-ring (1) is in place in groove on housing. Insert bearing housing bolts into bearing housing and screw about 12.7mm | 1/2" into frame to hold shaft during further assembly.

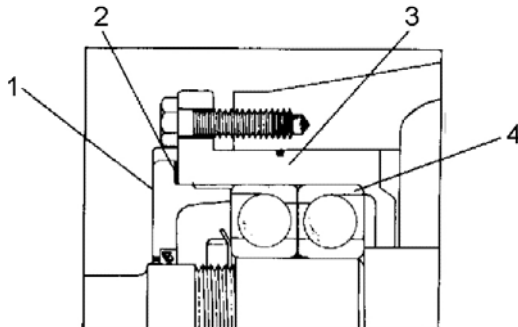


1. O-ring

Figure 78: Bearing housing O-ring

9. Tap oil seal into the bearing end cover (inboard).
10. Slide gasket and inboard bearing end cover over shaft and bolt to bearing frame.
11. Slide deflector on shaft with flat side in until it rests against the bearing frame.
12. Bearing end play may be determined at this point as follows: Clamp dial indicator to the pump so that the button rests against the end of the shaft. Push the shaft back and forth as far as possible. Total end play must be at least 0.025 | 0.001" and not more than 0.203mm | 0.008". If end play is

less than 0.025mm | 0.001" add coupling end bearing end cover gaskets made from 0.152mm | 0.006" thick manila paper. If end play is greater than 0.203mm | 0.008" remove gaskets. Because of machining tolerances, duplex thrust bearings may vary in width by up to 0.762mm | 0.030". A correctly assembled pump may require as few as one, or as many as three 0.152mm | 0.006" thick gaskets. Refer to image below.



1. Bearing end cover
2. Gaskets - 0.006" thick
3. Bearing housing
4. Duplex thrust bearing

Figure 79: Bearing end play

13. Install and position coupling hub at scribe mark on shaft.
14. Bolt bearing frame to frame adapter.

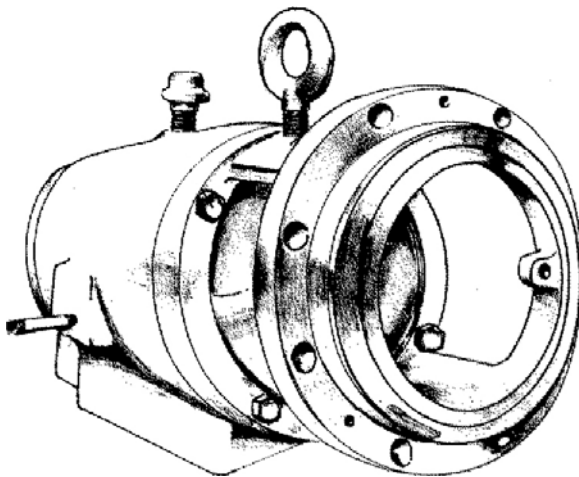


Figure 80: Bearing frame to bearing adapter

15. To install shaft sleeve and stuffing box cover:
 - a) On units with a packed stuffing box, slide shaft sleeve with O-ring in place on the shaft. Tap stuffing box bushing into place by using a sleeve. Check sleeve O.D. and bushing I.D. so it meets requirements of [6.7 Inspection and Overhaul on page 72](#). Lift stuffing box cover into position at impeller end of shaft. Guide stuffing box cover over shaft and sleeve to prevent contact to these surfaces. Bolt the stuffing box cover to the frame adapter.
 - b) On units with a mechanical seal, refer to the order acknowledgement and seal drawing (supplied with the pump) to determine seal type and mounting dimensions.
16. The following instructions refer to pumps equipped with mechanical seals.
 - a) Before mounting any seals, wipe the seal faces carefully with a clean, soft cloth and oil lightly with clean oil.

- b) Assemble gland, stationary seat, gland and seat gaskets. Carefully slide assembly on sleeve.
- c) Lightly oil the rotary portion of the seal and slide on sleeve. Position rotary at proper distance from end of sleeve. Correct dimension is shown on the seal drawing. See [6.9 Set the Mechanical Seals on page 79](#) for methods of positioning the rotary.
- d) Slide the stuffing box cover over shaft. Bolt the stuffing box cover to the frame adapter.

NOTICE:

Be careful not to damage seal on units with double seals. Make sure inboard stationary seat is properly positioned.

17. Place stuffing box cover-to-casing gasket against shoulder of stuffing box cover. Small amounts of O-ring lube may be used on both sides of gasket to seal and secure gasket in place.

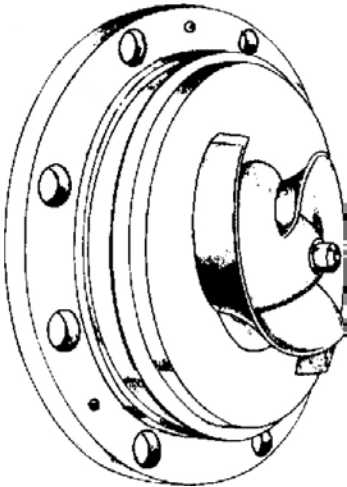


Figure 81: Stuffing box cover-to-casing gasket

18. Lubricate shaft keyway and insert impeller key in shaft and shaft sleeve. Lubricate shaft and slide impeller on shaft as far as possible. Replace impeller screw O-ring every time impeller is removed. Apply thread locker (Loctite 246 or equivalent) to impeller screw, install, and pull impeller on shaft the remainder of distance with impeller screw. Torque impeller screw to 300 N-m (220 ft-lb) for 7/8in screw and 954 N-m (704 ft-lb) for 1-1/4in screw. Prevent shaft from rotating by using a spanner or strap wrench.
19. Place O-ring in outer groove of suction sideplate. Install the sideplate-to-casing gasket. Tighten the four sideplate-to-casing studs in tapped holes in sideplate. Place suction sideplate in casing, making sure not to damage the sideplate O-ring. Liberal amounts of O-ring lube may be used to assist in sliding in place. Install and tighten four nuts on sideplate-to-casing studs.
20. Tighten casing hold down bolts.
21. Connect suction and discharge flanges. Care should be taken to prevent excessive pump flange loading.

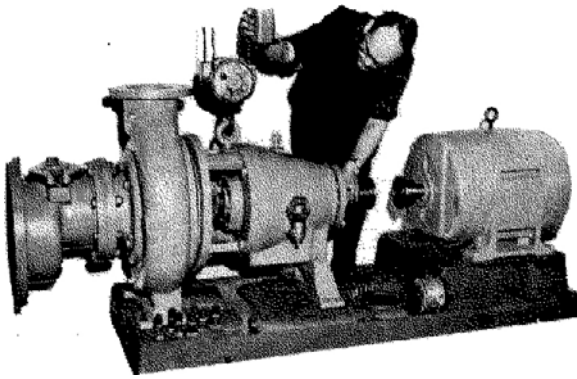


Figure 82: O-ring and suction sideplate-to-casing gasket

22. Slide the completely assembled "back-pull-out" unit into the casing. Tighten the frame adapter to casing bolts evenly to assure that gap between adapter and casing is even. Check with a feeler gauge at 4 points 90° apart around the adapter.



WARNING:

Lifting and handling heavy equipment or components poses a crush hazard. Use caution during lifting and handling and wear appropriate Personal Protective Equipment (PPE, such as steel-toed shoes, gloves, etc.) at all times. Seek assistance if necessary.

Follow torque specifications in the table below for frame adaptor to casing bolts.

Table 10: Frame Adapter to Casing Bolts Torque Specifications

Casing Size	Torque, N-m ft-lbs
12 inch	91 67
14 inch	244 180
18 inch	201 148
22 inch	233 172
28 inch	499 368

23. Install pedestal hold-down bolts. Frame pedestal is not to be flush with bedplate. Clearance of 1/4" is normal. Install shims under pedestal before tightening.
24. Set impeller clearance as outlined in [6.3 Impeller Clearance Adjustment on page 64](#). Clearance between impeller and sideplate should be set at 0.381mm | 0.015" to maintain optimum efficiency. Overall travel must be 1.499mm to 2.159mm | 0.059" to 0.085" dependent on tolerances. If not, check casing gasket to be sure it is 1.588mm | 1/16" thick.
25. If unit requires stuffing box packing, refer to [5.4 Stuffing Box Packing on page 42](#) and pack as directed. Refer also to [6.10 Stuffing Box on page 80](#) for alternate methods of packing.
26. Replace auxiliary piping.
27. Follow procedures outlined in this manual for preparation and operation of the unit.

NOTICE:

Pay particular attention to instructions concerning alignment and lubrication.

6.9 Set the Mechanical Seals



WARNING:



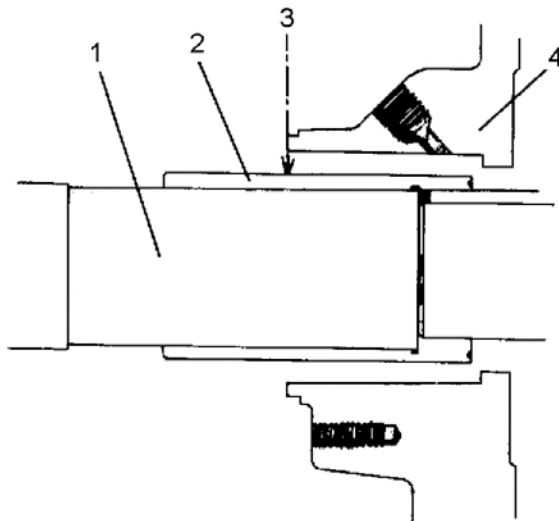
The mechanical seal used in an Ex classified environment must be properly certified.



CAUTION:

Running a mechanical seal dry, even for a few seconds, can cause seal failure and physical injury. Never operate the pump without liquid supplied to the mechanical seal.

1. With the bearing frame-shaft assembly completed, carefully slide the gland-stationary seat assembly, with gaskets in place on the shaft. Install shaft sleeve.
2. Carefully slide the stuffing box cover over the sleeve and bolt to the bearing frame.
3. The following method may be employed to determine the correct positioning of the rotary portion of the mechanical seal:
 - a) Scribe the shaft sleeve at the face of the stuffing box.



1. Shaft
2. Sleeve
3. Scribe
4. Stuffing box

Figure 83: Shaft sleeve

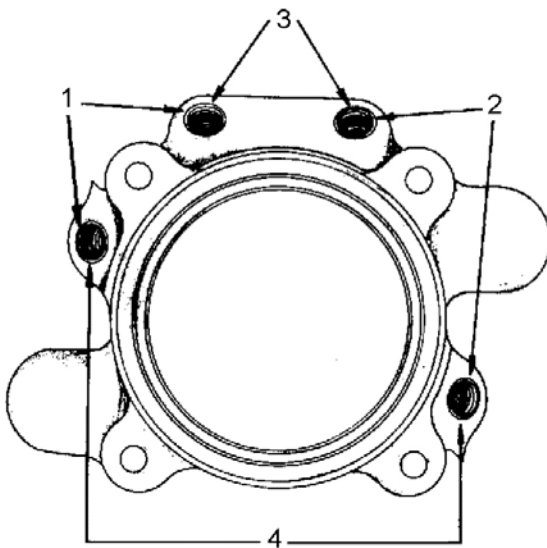
- b) Unbolt and remove the stuffing box cover. Remove sleeve. Lightly lubricate the rotary portion of the seal and slide onto the sleeve.
- c) Compress the rotary to the correct "working length". Refer to the seal manufacturer's drawing for correct dimensions. Tighten set screws.

6.10 Stuffing Box

**WARNING:**

Packed stuffing boxes are not allowed in an Ex-classified environment.

The standard stuffing box cover has four pipe taps for sealing or flushing liquid to the packing or mechanical seal. Two are used for in and out connections to the throat of the stuffing box for paper stock services with the lantern ring positioned next to the stuffing box throat bushing. Two are alternately used for evaporator or chemical services as in and out connections. The image below shows a stuffing box and location of holes, and the holes used for evaporator service and paper stock service.



1. Out
2. In
3. For paper stock service
4. For process and evaporator service

Figure 84: Stuffing box

6.11 Shaft guard installation (if provided)

6.11.1 Install the shaft guard

**WARNING:**

- Running a pump without safety devices exposes operators to risk of serious personal injury or death. Never operate a unit unless appropriate safety devices (guards, etc.) are properly installed.
- Failure to disconnect and lock out driver power may result in serious physical injury or death. Always disconnect and lock out power to the driver before performing any installation or maintenance tasks.

- Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
 - Refer to driver/coupling/gear manufacturer's installation and operation manuals (IOM) for specific instructions and recommendations.
-

Exposed rotating shaft between pump seal and bearing frame. Avoid contact and/or install proper guarding. If guarding is not provided with the pump, contact Goulds for price and availability of proper guarding.

1. Assemble a guard half from each side of the pump and fasten to the bearing frame.

7 Troubleshooting

7.1 Troubleshooting Checklist

1. No liquid delivered
 1. Pump not primed - casing and suction pipe not completely filled with liquid.
 2. Speed too low.*¹
 3. Discharge head too high. Check system head (particularly friction loss).
 4. Suction lift too high (suction pipe may be too small or long, causing excessive friction loss). Check with vacuum or compound gauge.
 5. Impeller or suction pipe or opening completely plugged.
 6. Wrong direction of rotation or impeller installed backwards.
 7. Air pocket in suction line.
 8. Stuffing box packing worn - or liquid seal plugged - allowing leakage of air into pump casing.
 9. Air leak in suction line.
 10. Not enough suction head for hot or volatile liquids. Check carefully as this is a frequent cause of trouble on such service.
2. Not enough liquid delivered
 1. Pump not primed - casing and suction pipe not completely filled with liquid.
 2. Speed too low.*²
 3. Discharge head higher than anticipated. Check system head (particularly friction loss).
 4. Suction lift too high (suction pipe may be too small or long, causing excessive friction loss.) Check with vacuum or compound gauge.
 5. Impeller or suction pipe or opening partially plugged.
 6. Wrong direction of rotation or impeller installed backwards.
 7. Air pocket in suction line.
 8. Stuffing box packing worn - or liquid seal plugged - allowing leakage of air into pump casing.
 9. Air leak in suction line.
 10. Not enough suction head for hot or volatile liquids. Check carefully as this is a frequent cause of trouble on such service
 11. Foot valve too small.
 12. Foot valve or suction pipe not immersed deeply enough.
 13. Mechanical defects:
 - Impeller clearance too great
 - Impeller damage
3. Not enough pressure
 1. Speed too low.*³
 2. Air or gases in liquid.
 3. Impeller diameter may be too small.
 4. Mechanical defects:
 - Impeller clearance too great
 - Impeller damage

-
5. Wrong direction of rotation or impeller installed backwards.
 6. Be sure pressure gauge is in correct place on discharge nozzle or discharge pipe.
 4. Pump works a while and then quits
 1. Leaky suction line.
 2. Stuffing box packing worn - or liquid seal plugged - allowing leakage of air into pump casing.
 3. Air pocket in suction line.
 4. Not enough suction head for hot or volatile liquids. Check carefully as this is a frequent cause of trouble on such service.
 5. Air or gases in liquid.
 6. Suction lift too high (suction pipe may be too small or long, causing excessive friction loss). Check with vacuum or compound gauge.
 7. Impeller plugged.
 8. Obstruction in suction or discharge line.
 9. Casing gaskets damaged.
 5. Pump takes too much power
 1. Speed too high.
 2. Head lower than rating, pumps too much liquid.
 3. Liquid heavier than anticipated. Check viscosity and specific gravity.
 4. Mechanical defects:
 - Shaft bent
 - Rotating element binds
 - Stuffing box too tight
 - Impeller clearance too great
 5. Wrong direction of rotation, or impeller installed backwards.
 6. Pump leaks excessively at stuffing box
 1. Packing is worn or not properly lubricated.
 2. Packing is incorrectly inserted or not properly run in.
 3. Packing is not correct for liquid handled.
 4. Shaft sleeve scored.
 5. Insufficient packing.
 6. Damaged mechanical seal.
 7. Pump is noisy or vibrates
 1. Hydraulic noise - cavitation, suction lift too high. Check with vacuum or compound gauge.
 2. Mechanical defects:
 - Shaft bent
 - Rotating parts bind, are loose or broken
 - Bearings worn out
 - Coupling misaligned
 8. High bearing temperature

See [6.1.1 Bearing Temperatures on page 59](#)

 1. Pump and driver misalignment.
 2. Pump capacity too low.
-

3. Improper lubrication.
4. Excessive vibration.
5. Bent shaft.
6. Rotating element binds.

- *1 When directly connected to electric motors, check whether motor wiring is correct and receives full voltage. When directly connected to steam turbines, make sure that turbine receives full steam pressure.
- *2 When directly connected to electric motors, check whether motor wiring is correct and receives full voltage. When directly connected to steam turbines, make sure that turbine receives full steam pressure.
- *3 When directly connected to electric motors, check whether motor wiring is correct and receives full voltage. When directly connected to steam turbines, make sure that turbine receives full steam pressure.

7.2 i-ALERT® Equipment Health Monitor troubleshooting

To troubleshoot the i-ALERT® Equipment Health Monitor, please refer to the i-ALERT® Equipment Health Monitor IOM or <https://www.ittproservices.com/Our-Services/Aftermarket-Products/Monitoring/i-ALERT2-condition-monitor/>

Symptom	Cause	Remedy
There are no green or red flashing LEDs.	The battery is dead.	Replace the condition monitor.
	The unit is deactivated.	Activate the condition monitor.
	The unit is malfunctioning.	Consult your ITT representative for a warranty replacement.
The red LEDs are flashing, but the temperature and vibration are at acceptable levels.	The baseline is bad.	Check the temperature and vibration levels and reset the condition monitor.
	The unit is malfunctioning.	Consult your ITT representative for a warranty replacement.

8 Parts List and Cross-Sectionals

8.1 Spare Parts

To ensure against possible long and costly "downtime" periods, especially on critical services, it is advisable to have spare parts on hand.

The most desirable parts to have on hand are the following:

1. Horizontally Split Case Pumps
 1. "Rotating element". This is a group of assembled parts, including bearings, bearing housings, shaft, impeller(s), wearing rings, stuffing box bushings, and all rotating parts except the coupling.
 2. Stuffing box packing (if any) - one set for each stuffing box.
 3. Stuffing box gland packing (if any) - one set for each gland.
 4. Mechanical Seals (if any) - one seal for each stuffing box.
2. Frame Mounted End Suction Pumps
 1. "Support Head". This is a group of assembled parts which includes all parts except the casing, suction cover and coupling. The impeller is not mounted on the shaft.
 2. Stuffing box packing (if any) - one set.
 3. Stuffing box gland packing (if any) - one set.
 4. Mechanical seal (if any) - one.
3. "Back Pull-Out" End Suction Pumps
 1. "Back Pull-Out assembly". This is a group of assembled parts which includes all parts except the casing and the coupling.
 2. Stuffing box packing (if any) - one set.
 3. Stuffing box gland packing (if any) - one set.
 4. Mechanical seal (if any) - one.

An alternate, though not as desirable as that stated above, is to have on hand parts that are most likely to wear and which can be used as needed.

Following is a list of these suggested parts:

1. Stuffing box packing (if any) - one set for each stuffing box.
2. Stuffing box gland packing (if any) - one set.
3. Mechanical seal (if any).
4. Shaft sleeve (if any).
5. Ball bearings - one of each.
6. Shaft nut (if any).
7. Bearing locknut and washer (if any).
8. Wearing rings (if any).
9. Shaft - one required.
10. Impeller key (if any).
11. Stuffing box bushings (if any).

If it is not convenient or desirable to carry the spare parts listed above, the following list is suggested as a minimum for servicing the pump under ordinary conditions of wear:

1. Stuffing box packing (if any) - one set for each stuffing box.
2. Stuffing box gland packing (if any) - one set.

3. Shaft sleeve (if any).
4. Ball bearings - one of each.
5. Shaft nut (if any).
6. Bearing locknut and washer (if any).

8.2 Instructions for Ordering Spare Parts

Repair orders will be handled with the minimum of delay if the following directions are followed:

1. Give Model No., size of the pump and serial number. These can all be obtained from the name-plate.
2. Write plainly the names, part numbers and materials of the parts required. These names and numbers should agree with those on the [8.3 Parts List on page 86](#).
3. Give the number of parts required.
4. Give complete shipping instructions.

8.3 Parts List

Table 11: Construction details

		Group S						Group M										Group L																			
		3x6-14	3x8-14	4x6-14	4x10-1	4x6-18	4x10-1	6x8-14	6x12-1	6x8-18	6x12-1	6x8-22	6x12-2	8x10-1	8x14-1	8x10-1	8x14-1	8x10-1	8x14-1	8x10-2	8x14-2	20x12-0	18x16-0	18x12-0	20x16-0	22x14-0	18x18-0	18x14-0	22x18-0	22x14-0	18x20-0	18x14-0	22x20-0	28x18-22			
General	Net wgt. bronze fitted bare pump w/ suction piece	850	925	1050	1100	1525	1700	1550	1600	1725	1800	1900	2050	2000	2350	2125	2800	4500																			
	Min. casing thickness C.I. bronze* ¹	9/16	19/32	21/32	21/32	23/32	12/16	11/16	3/4	13/16	7/8	7/8	15/16	15/16	31/32	31/32	1-1/16	1-1/4																			
	Min. casing thickness steel* ²	7/16	1/2	17/32	17/32	9/16	21/32	9/16	19/32	5/8	11/16	11/16	3/4	3/4	3/4	3/4	12/16	1-1/16																			
	Max. dia. solids	1-1/8	2	1-3/8	2-7/8	2	1-5/8	3-3/4	2-3/4	2-1/8	2-1/2	2-3/8	2-7/8	2-1/4	1-5/8	2-1/8	3																				
Pressure limits	Max. working pressure - PSIG	See Pressure - Temperature Chart 150% of maximum working pressure at 100°F																																			
	Max. test pressure - PSIG																																				
Temp. limits	Max liquid temp. oil lube without cooling	250°F 350°F for C.I. 450°F for Steel						250°F 350°F for C.I., 450F for Steel						250°F 350°F for C.I., 450F for Steel						250°F 350°F for C.I., 450F for Steel																	
	Max liquid temp. oil lube w/ frame cooling	250°F						250°F						250°F						250°F																	

		Group S							Group M												Group L													
		3x6-14	3x8-14	4x6-14	4x10-1	4x6-18	4x10-1	6x8-14	6x12-1	6x8-18	6x12-1	6x8-22	6x12-2	8x10-1	8x14-1	8x10-1	8x14-1	8x10-1	8x14-1	8x10-2	8x14-2	20x12-1	18x16-1	18x12-1	20x16-1	22x14-1	18x18-1	18x14-1	22x18-1	22x14-1	18x20-1	18x14-1	22x20-1	22x18-22
	Max liquid temp. grease lube																																	
HP limits	H.P. per 100RPM	9.52							23.8												63.5													
Shaft Dia.	At impeller	1-7/8							2-3/4												3 ^{3/8}													
	Under shaft sleeve	2-1/2							3-5/16												4 ^{5/16}													
	At coupling	1-7/8							2-3/8												3 ^{3/8}													
	Between bearings	3-1/8							4												4 ^{7/8}													
Sleeve O.D.	Thru stuffing box	3							3 ^{3/4}												4 ^{3/4}													
Bearings	Coupling end Inboard (pump end) Bearing span	MRC 7313 DB or equal MRC 313 S or equal 12-1/4							MRC 7317 DB or equal MRC 317 M or equal 11-11/16												MRC 7222 P.D.B or equal MRC 222 M or equal 11 ^{1/8}													
	Shaft overhang	10 ³¹ / ₃₂	11 ¹³ / ₃₂	11 ¹¹ / ₁₆	11 ²⁷ / ₃₂	11 ¹⁹ / ₃₂	11 ¹³ / ₃₂	12 ⁷ / ₁₆	11 ²⁹ / ₃₂	12 ⁷ / ₃₂	11 ⁵ / ₈	12 ⁹ / ₁₆	1 ¹ / ₇ 8	12 ¹³ / ₁₆	12 ¹ / ₁₆	13 ¹ / ₈	12 ³ / ₈	13 ⁷ / ₃₂																
Stuffing box	Bore																																	
	Depth to stuffing box bushing																																	
	Packing size	4							4-3/4												5-3/4													
	Number packing rings	3-11/16							3-11/16												3-11/16													
	Width of lantern ring	1/2 x 1/2							1/2 x 1/2												1/2 x 1/2													
	Distance from end of stuffing box to nearest obstruction	5							5												5													

*1 Includes 1/8 corrosion allowance

*2 Includes 1/8 corrosion allowance

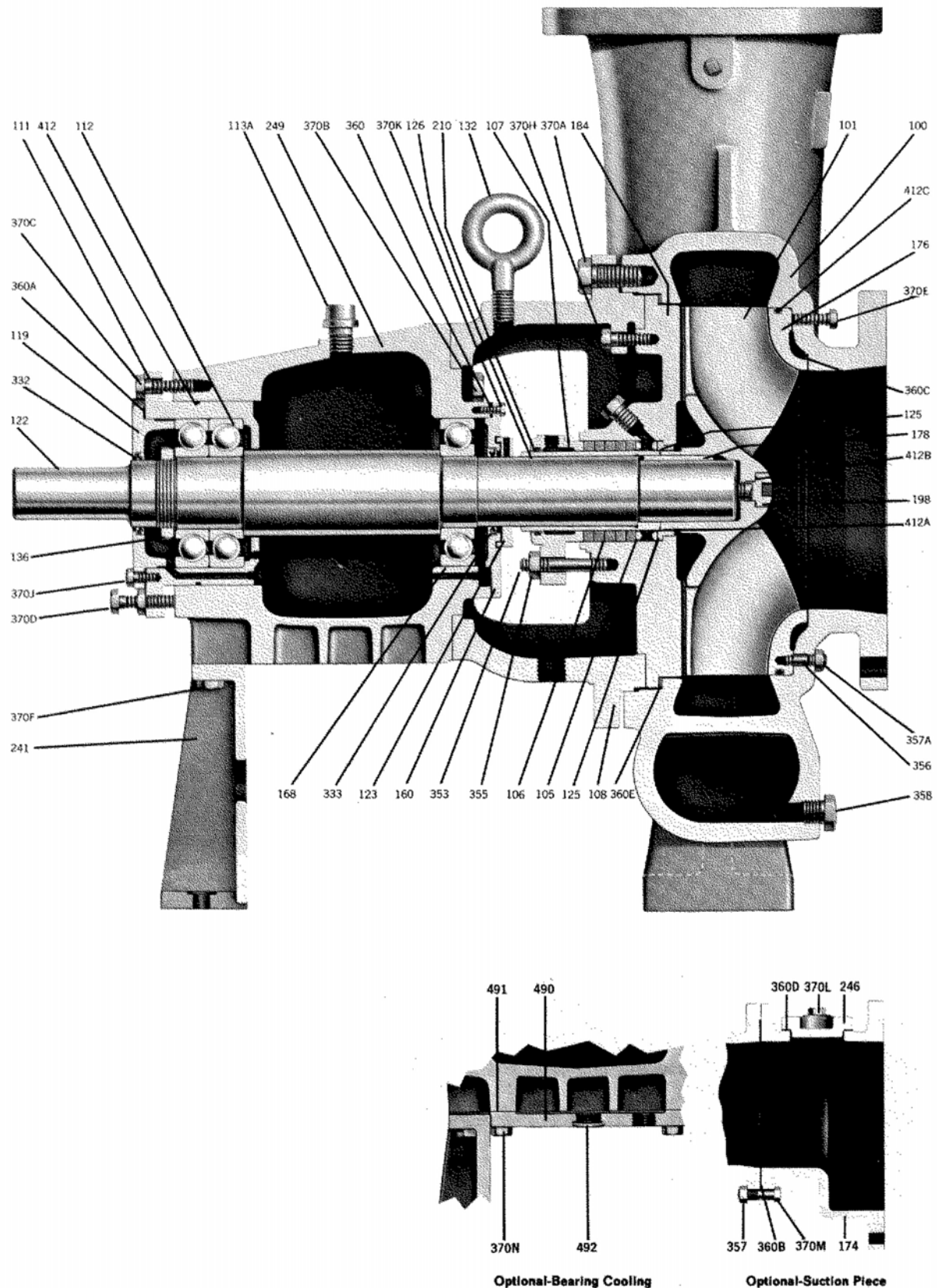


Figure 85: Sectional View and Parts List

Table 12: Materials of Construction

Material	Cu %	Sn %	Ph %	Zn %	Ni %	P %
1102	84-86	4-6	4-6	4-6	-	-
1103	87	6	4.5	1.75	0.75	-
1106	84	8	8	-	-	0.10-0.15

1000 - Cast Iron - conforms to ASTM A-278 Class 25

1003 - Cast Iron - conforms to ASTM A-278 Class 30

303 - Designates AISI Type 303 stainless steel

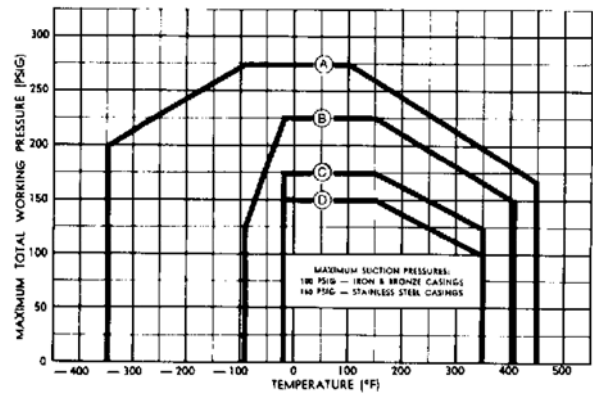
316 - Designates AISI Type 316 stainless steel (wrought) or ASTM A-296 Grade CF-8M and ACI-CF-8M (cast)

Table 13: Pressure Temperature Capability

Pump Size	Curve	Pump Casing Material	Acceptable Minimum Standard ANSI* ¹ Mating Flanges and Fittings	
			Discharge	Suction
3 x 6-14	A	316 Stainless steel	150 PSI flat face steel	150 PSI flat face steel
4 x 6-14	B	Bronze (1103)	150 PSI flat face bronze or steel	150 PSI flat face bronze or steel
4 x 6-18	C	Cast iron (1003)	125 PSI cast iron	125 PSI cast iron
6 x 8-14				
6 x 8-18				
6 x 8-22				
8 x 10-14				
8 x 10-18				
8 x 10-18H				
8 x 10-22				
10 x 12-18				
10 x 12-22				
12 x 14-18 12 x 14-22	A	316 Stainless steel	150 PSI flat face steel	150 PSI flat face steel
	B	Bronze (1103)	150 PSI flat face bronze or steel	150 PSI flat face steel
	C	Cast iron (1003)	125 PSI cast iron	125 PSI cast iron
14 x 14-18	A	316 Stainless steel	150 PSI flat face steel	150 PSI flat face steel
14 x 14-22	B	Bronze (1103)	150 PSI flat face steel	150 PSI flat face steel
18 x 18-22	D	Cast iron (1003)	125 PSI cast iron	125 PSI cast iron

*1 American National Standards Institute, formerly USASI and ASA

For other materials, refer to factory



8.4 Parts list and interchangeability chart

Table 14: Parts List and Interchangeability Chart

			Material						Group S				Group M								Group L					
Item No.	No. required per pump	Part Name	Bronze fitted	All iron	All bronze	All 316SS	All iron SS trim	All bronze SS trim	3x6-14 and 3x8-14	4x6-14 and 4x10-14	4x6-18 and 4x10-18	6x8-14 and 6x12-14	6x8-18 and 6x12-18	6x8-22 and 6x12-22	8x10-14 and 8x14-14	8x10-18 and 8x14-18	8x10-18H and 8x14-18H	8x10-22 and 8x14-22	10x12-18 and 10x16-18	10x12-22 and 10x16-22	12x14-18 and 12x18-18	12x14-22 and 12x18-22	14x14-18 and 14x20-18	14x14-22 and 14x20-22	18x18-22	
100	1	Casing	1003	1103	3106	1003	1103	3																		
101	1	Impeller	1106	1000	1106	3106	3106	316																		
105	1	Lantern ring	Glass filled PTFE						S				M								L					
106	1 set	Stuffing box packing	Non-asbestos						S				M								L					
107	2 halves	Stuffing box gland	1103	1000	1103	3106	1000	1103	S				M								L					
108	1	Frame adapter	1000						A	A	B	A	B	C	A	B	B	C	B	C	B	C	B	C	C	C
111	1	Bearing housing	1000						S				M								L					
112	1	Ball bearing coupling end	Steel						S				M								L					
113 A	1	Breather	Steel						S				S								S					
119	1	Bearing, end cover coupling end	1000						S				M								L					
122	1	Shaft	SAE 4140	AISI 303	SAE 4140	AISI 303	S				M								L							
123	1	Deflector	1000						S				M								L					

8.4 Parts list and interchangeability chart

			Material						Group S				Group M								Group L					
Item No.	No. required per pump	Part Name	Bronze fitted	All iron	All bronze	All 316SS	All iron SS trim	All bronze SS trim	3x6-14 and 3x8-14	4x6-14 and 4x10-14	4x6-18 and 4x10-18	6x8-14 and 6x12-14	6x8-18 and 6x12-18	6x8-22 and 6x12-22	8x10-14 and 8x14-14	8x10-18 and 8x14-18	8x10-18H and 8x14-18H	8x10-22 and 8x14-22	10x12-18 and 10x16-18	10x12-22 and 10x16-22	12x14-18 and 12x18-18	12x14-22 and 12x18-22	14x14-18 and 14x20-18	14x14-22 and 14x20-22	18x18-22	
125	1	Stuffing box throat bushing	1103	1000	1103	AI SI 316	1000	1103	S				M								L					
126	1	Shaft sleeve	1106	1000	1106	AISI 316			S				M								L					
132	1	Eye bolt	Steel						S				S								S					
136	1	Bearing lock-nut w/lock-washer	Steel						S				M								L					
160	1	Bearing end cover, in-board	1000						S				M								L					
168	1	Ball bearing, inboard	Steel						S				M								L					
174	1	Suction piece	1000	1103	316	1000	1103		A	B	B	C	C	C	D	D	D	D	E	E	F	F	G	G		
176	1	Suction side plate	1000	1106	316	1000	1106		A	B	C	D	E	F	G	H	J	K	N	O	P	Q	P	Q	R	
178	1	Impeller key	AISI 303						S				M								L					
184	1	Stuffing box cover	1000	1103	AI SI 316	1000	1103		A	A	B	A	D	E	F	D	D	E	D	G	H	G	H	G	G	
198	1	Impeller screw	AISI 316						S				S								S					
210	1	Gland packing	Non-asbestos						S				M								L					
241	1	Frame pedestal	1000						A	A	B	B	C	D	C	D	D	E	E	F	G	G	G	H	J	

			Material						Group S				Group M						Group L							
Item No.	No. required per pump	Part Name	Bronze fitted	All iron	All bronze	All 316SS	All iron SS trim	All bronze SS trim	3x6-14 and 3x8-14	4x6-14 and 4x10-14	4x6-18 and 4x10-18	6x8-14 and 6x12-14	6x8-18 and 6x12-18	6x8-22 and 6x12-22	8x10-14 and 8x14-14	8x10-18 and 8x14-18	8x10-18H and 8x14-18H	8x10-22 and 8x14-22	10x12-18 and 10x16-18	10x12-22 and 10x16-22	12x14-18 and 12x18-18	12x14-22 and 12x18-22	14x14-18 and 14x20-18	14x14-22 and 14x20-22	18x18-22	
246	1	Hand hole cover	1000		1103	316	1000	1103	S				S						S							
247	1	Drip basin, not shown	-		316		-	316	S				S						S							
248	1	Bearing frame	1000						S				M						L							
251	1	Bottle oiler constant level							S				S						S							
332	1	Oil seal, coupling end							S				M						L							
333	1	Oil seal, in-board							S				M						L							
353	2	Gland stud	AISI 303						S				S						S							
355	2	Gland stud nut	AISI 304						S				S						S							
356	4	Stud, suction side plate to casing	AISI 303						A	A	A	A	A	A	B	A	A	C	A	C	A	B	A	C	C	
357	8-20	Hex nut, suction piece to casing bolt	Steel						A	A	A	A	A	A	B	B	B	B	B	B	B	B	C	C	C	C
357 A	4	Hex nut, side plate stud	AISI 303						S				S						S							
358	1	Pipe plug, casing drain	1102	1000	1102	316	1000	1102	S				S						S							
360	1	Gasket, bearing end cover, in-board	.006 white manilla paper						S				M						L							
360 A	1	Gasket, bearing end	.006 white manilla paper						S				M						L							

8.4 Parts list and interchangeability chart

			Material					Group S				Group M						Group L							
Item No.	No. required per pump	Part Name	Bronze fitted	All iron	All bronze	All 316SS	All iron SS trim	All bronze SS trim	3x6-14 and 3x8-14	4x6-14 and 4x10-14	4x6-18 and 4x10-18	6x8-14 and 6x12-14	6x8-18 and 6x12-18	6x8-22 and 6x12-22	8x10-14 and 8x14-14	8x10-18 and 8x14-18	8x10-18H and 8x14-18H	8x10-22 and 8x14-22	10x12-18 and 10x16-18	10x12-22 and 10x16-22	12x14-18 and 12x18-18	12x14-22 and 12x18-22	14x14-18 and 14x20-18	14x14-22 and 14x20-22	18x18-22
		cover, coupling end																							
360 B	1	Gasket, suction piece to casing	Non-asbestos					A	A	A	B	B	B	C	C	C	C	C	D	D	E	E	E	E	
360 C	1	Gasket, side plate to casing	Non-asbestos					A	B	B	C	C	D	E	E	F	G	H	H	J	K	N	K	N	N
360 D	1	Gasket, hand hole cover	1/8 cloth inserted rubber					S				S						S							
360 E	1	Gasket, stuffing box cover to casing	Non-asbestos					A	A	B	A	B	C	A	B	B	C	B	C	B	C	C	C	C	C
370 A	8-16	H.H.M. bolt, adapter to casing	A193 Gr. B7.					S				S						S							
370 B	4	H.H.M. bolt, adapter to frame	Steel					S				S						S							
370 C	4	H.H. tap bolt, bearing housing to frame	Steel					S				S						S							
370 D	4	H.H. tap bolt with jam nut, impeller adjust	Steel					S				S						S							
370 E	3	H.H. tap bolt side plate removal	AISI 303					S				S						S							
370 F	2	H.H.M. bolt, with lock-washer,	Steel					S				S						S							

			Material					Group S				Group M							Group L						
Item No.	No. required per pump	Part Name	Bronze fitted	All iron	All bronze	All 316SS	All iron SS trim	All bronze SS trim	3x6-14 and 3x8-14	4x6-14 and 4x10-14	4x6-18 and 4x10-18	6x8-14 and 6x12-14	6x8-18 and 6x12-18	6x8-22 and 6x12-22	8x10-14 and 8x14-14	8x10-18 and 8x14-18	8x10-18H and 8x14-18H	8x10-22 and 8x14-22	10x12-18 and 10x16-18	10x12-22 and 10x16-22	12x14-18 and 12x18-18	12x14-22 and 12x18-22	14x14-18 and 14x20-18	14x14-22 and 14x20-22	18x18-22
		pedestal to frame																							
370 H	2	H.H.M. bolt, adapter to S.B. cover	Steel					S				S							S						
370 J	6	H.H.M. bolt, bearing end cover to housing - coupling end	Steel					S				S							S						
370 K	6	H.H.M. bolt, bearing end cover to frame in-board	Steel					S				S							S						
370 L	2	H.H.M. bolt, hand hole cover	Steel					S				S							S						
370 M	8-20	H.H.M. bolt, suction piece to casing	Steel					A	A	A	A	A	A	B	B	B	B	B	B	B	C	C	C	C	
370 N	10	H.H.M. bolt, water jacket cover	Steel					S				S							S						
412	1	O-ring, bearing housing	Buna-N					S				M							L						
412 A	1	O-ring, shaft sleeve	PTFE					S				M							L						
412 B	1	O-ring, im-peller screw	PTFE					S				S							S						
412 C	1	O-ring, suction side plate	Buna-N					A	A	B	A	B	C	A	B	B	C	B	C	B	C	C			

8.4 Parts list and interchangeability chart

			Material					Group S				Group M							Group L						
Item No.	No. required per pump	Part Name	Bronze fitted	All iron	All bronze	All 316SS	All iron SS trim	All bronze SS trim	3x6-14 and 3x8-14	4x6-14 and 4x10-14	4x6-18 and 4x10-18	6x8-14 and 6x12-14	6x8-18 and 6x12-18	6x8-22 and 6x12-22	8x10-14 and 8x14-14	8x10-18 and 8x14-18	8x10-18H and 8x14-18H	8x10-22 and 8x14-22	10x12-18 and 10x16-18	10x12-22 and 10x16-22	12x14-18 and 12x18-18	12x14-22 and 12x18-22	14x14-18 and 14x20-18	14x14-22 and 14x20-22	18x18-22
490	1	Water jacket cover, optional	1000					S				S							S						
491	1	Gasket, water jacket cover	Non-asbestos					S				S							S						
492	1	Welch plug	416SS					S				S							S						

8.5 Pump Selection Chart

Table 15: Index and Selection

	Model Number and Pump Type	Described in Bulletin	No. of Sizes and Ranges	Max. Capacity G.P.M.	Max Head Feet	Max Temp. °F	Max Working Pressure	Type of Impeller	Class of Construction
Process	3196-STD AVS Chemical	725.1	18 1" - 4"	1600	750	500	375	Open	A, B, C, F
	3196-XL 3196-HT	725.1 XL	5 6" & 8"	4250	230	500 700	375	Open	A, B, C, F A, B, C
	3706 Small glassed	725.2	1 1"	100	115	350	150	Open	D
	3708 Glassed	725.2	4 1" - 3"	700	150	350	150	Semi-Open	D
	3107 PTFE	725.3	1 1"	70	110	300	150	Open	E
	3198 AVS PTFE	725.3	2 1 ½" & 3"	800	410	300	225	Open	E
	2520 Liquid Ring	725.6	1 1 ½"	60	85	212	75	Strgt. Blade	1 & B
	3604 Close-Coupled Small Alloy	725.7	1 ¾"	16	28	220	75	Semi-Open	B
	3199 Single Stage, Direct Con.	725.8	3 1" - 1 ½"	220	150	350	150	Open	A, B, C
High Temp. Process	3716 Cer-Vit		1 1 ½"	140	140	350	100	Open	Cer. - Vit
	3735-HPI Centerline mounted	724.2	21 1" - 6"	1900	900	800	600	Encl.	C
Stock	3736 HPI Foot mounted	724.2	21 1" - 6"	1900	900	500	600	Encl.	C
	3135 Diagonally split casing	723.1	12 3" - 8"	4000	300	200	150	Open	A, B, C
General Service	3175 Back pull out	723.4	17 3" - 18"	12500	320	450	275	Open	A, B, C
	3655 Single Stg, Close Coupled	710.1	25 1 ¼" - 8"	3800	400	250	150	Encl.	A

8.5 Pump Selection Chart

	Model Number and Pump Type	Described in Bulletin	No. of Sizes and Ranges	Max. Capacity G.P.M.	Max Head Feet	Max Temp. °F	Max Working Pressure	Type of Impeller	Class of Construction
	3755 Single stage, direct Con.	715.1	25 1 ¼" - 8"	3800	400	350	150	Encl.	A
	3345 Two Stg, Direct Con.	718.2	1 1"	120	500	350	250	Encl.	A
	3320 Two Stg, Close-Coupled	713.1	1 1"	120	500	250	250	Encl.	A
	3189 Single Stg, Direct Con.	720.4	2 6" & 8"	3200	155	350	150	Open	A
Multi Stage	3316 Two stage	722.6	10 1" - 8"	3000	1000	400	500	Encl.	A & B in all sizes. C in most sizes
	3330 Medium Pressure	722.1	21 3" - 8"	2100	1000	350	370	Encl.	A & B
	3360-65 High Pressure	722.4	11 3" - 8"	2600	3400	350	1200	Encl.	A & B
Double Suction	3405	721.6	39 2" - 12"	6400	550	350	250	Encl.	A & B in all sizes. C in 4" - 12"
	3404 Vertically Mtd.	721.15	39 2" - 12"	6400	525	350	250	Encl.	A & B in all sizes. C in 4" - 12"
	3415DV	721.7	8 8" - 18"	15000	550	275	275	Encl.	A, B, C
	3420-23 Horiz. & Bottom Suction	721.8 and .9	7 16" - 36"	75000	400	275	200	Encl.	A, B, C
	3450-60 Horiz. & Bottom Suction	721.2	3 14" - 16"	16000	200	250	250	Encl.	A
Vertical	3171 Vertical Centrifugal	726.1	21 1" - 8"	3180	290	450	150	Open	A & C
	VIT Vertical Turbine	3A.1	18 4" - 36"	20000	3000	250	-	Open	1, 3, 5, 8

Table 16: Materials of Construction

The table at the right shows a code for construction materials. They are listed in the last column of the Index and Selection chart above. Materials listed include both normal inventory alloys and some others built only to order. For specific information on delivery consult your Goulds sales engineer.

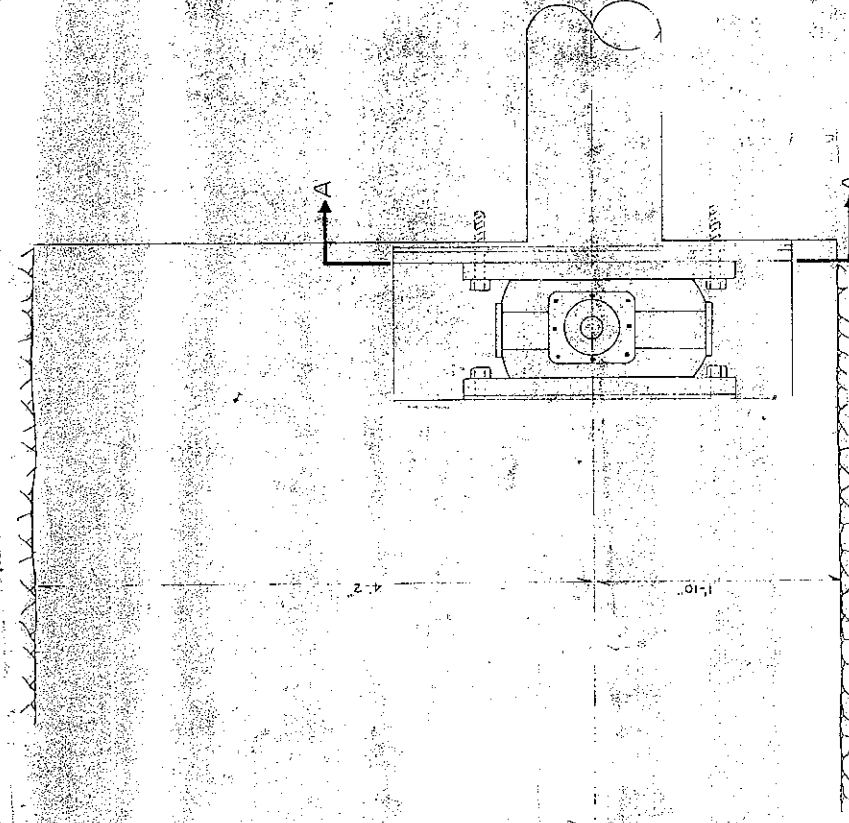
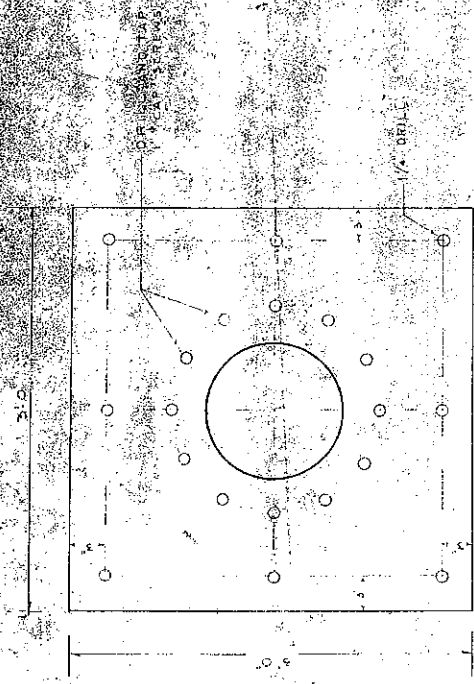
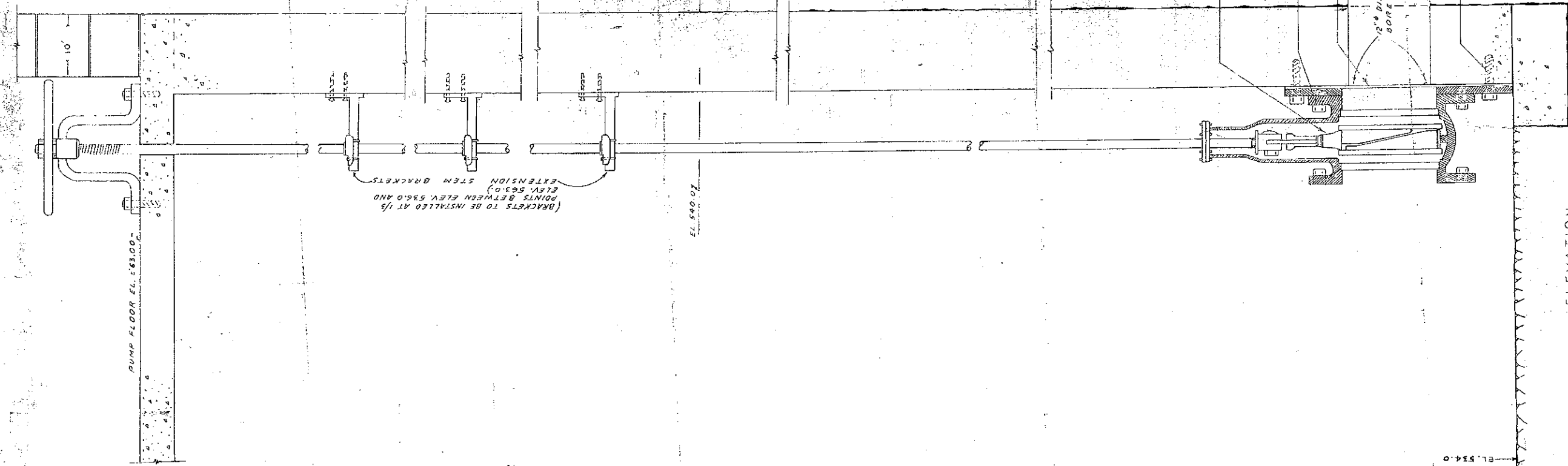
Class		Materials of Construction
A	1	All iron (ASTM A278)
	2	Bronze fitted
	3	All bronze. See bulletin for spec.
	4	Ductile iron (ASTM A395)
B	5	Ni-Resist (Type 2) (ASTM A436)
C	6	Carbon steel (ASTM A216 Grade WCA & WCB)
	7	11-13% chrome stainless (ACI CA15)
	8	316 stainless (ACI CF8M)
	9	Gould A LOV 20 (ACI CN 7 MCU)
	10	Other special sand cast machinable alloys such as low, medium and high carbon steels, ACI CF 8C (347) 316 ELC, monel, nickel.
	11	ISO B and C
D	12	All iron, glassed
E	13	Ductile iron, molded-in-place PTFE
F	14	Titanium

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www.gouldspumps.com



ITT Goulds Pumps, Inc.
240 Fall Street
Seneca Falls, NY 13148
USA

Form IOM.3175.en-US.2023-07



PLAN REVISED MARCH 27, 1972 DWG. NO. 5

PLAN SHOWING
DETAILS OF INTAKE VALVE AND SCREEN
FOR PUMP HOUSE AT EXIT OF
H.E.P.C. TWIN TUNNELS

FOR THE
SIR ADAM BECK & SONS

REGIONAL MUNICIPALITY OF NIAGARA

SCALE: 1" = 1'-0"

R. BLAKE ERWIN
CONSULTING ENGINEER
NIAGARA FALLS, ONT.

DATE: APRIL 9, 1972

FILE NO.

R. BLAKE ERWIN, P. ENG.



Concord Screen Inc.
1311 Kerrisdale Blvd
Newmarket Ontario
L3Y 8Z8

Quotation

Date	Quotation #
2/18/2026	8834

Name/Address
AECOM 50 Sportsworld Crossing Drive Suite 290 Kitchener, ON N2P 0A4

From: Richard Gu Sales Representative Ph: 1-905-953-8100 X312 Fax: 1-905-953-8105 richardgu@concordscreen.com
--

Project	FOB	Terms
	Newmarket, ON	

Description	Qty	Rate	Total
Wedgewire tee style intake screen is 48" OD X approximately 140" effective screen length constructed using number 90 wrap wire with 0.240" slot opening, screen offers 72.72 percent open area. Standard wound construction for outside to inside flow direction. Screen offers estimated velocity of 0.32 feet per second based on maximum flow rate of 15,000 GPM. Supplied with centre tee section and 30" fabricated outlet flange (drilled to match AWWA Class D). Intake screen will be supplied with solid cap at one end and deflector cone at the other end. Screen will be fitted with lifting lugs. Includes 4" airburst connection and internals as required to facilitate air burst. Also includes internal flow modifier. All fabricated from copper nickel 90/10 Budgetary price subject to change. HST (ON) on sales	1	99,500.00	99,500.00
		13.00%	12,935.00
Due to current market conditions quoted delivery is estimated and subject to change. Certain materials may also decrease the validity date of quotation.			
Quote based on Concord Screen Inc., standard terms and conditions of sale. Prices exclude Freight.		Total	CAD 112,435.00
Web Site	http://www.concordscreen.com	Fax #	905-953-8105
		Phone #	905-953-8100

Appendix E.



Niagara Irrigation Initiative Project

Class 4 Estimate

Project Number	60757321
Issued Date	20 February 2026
Client	Region of Niagara
Prepared By	Patwant Bhullar
Checked By	Charles Bichage

Delivering a better world

NOTL Irrigation Infrastructure "Class 4" Construction Cost Estimate

Executive Summary

#	Item Description	Dee Road Pumping Station	Eastchester Pumping Station
NOTL Irrigation Infrastructure			
	Sub total (irrigation upgrades)	\$9,946,900.00	\$15,568,000.00
	Sub total	\$9,946,900.00	\$15,568,000.00
	Total	\$9,946,900.00	\$15,568,000.00
	General Requirements & Fee		
	Construction overhead @ 15%	\$1,492,000.00	\$2,335,200.00
	Other misc. (mobilization, demobilization, insurance, bonds, etc..) @ 8%	\$795,800.00	\$1,245,400.00
	Net Total Construction Cost (Excluding Contingencies)	\$12,234,700.00	\$19,148,600.00
	Contingencies		
	Design Contingency (30%)	\$2,984,100.00	\$5,744,600.00
	Site Constraints (10%)	\$1,223,470.00	\$1,914,860.00
	Escalation (0%)	\$0.00	\$0.00
	Net Total Construction Cost (Excluding PST)	\$16,442,270.00	\$26,808,060.00
	HST	\$0.00	\$0.00
	Net Total Construction Cost (Including PST)	\$16,442,270.00	\$26,808,060.00
	Allowances		
	Construction Contingency (10%)	\$1,644,200.00	\$2,680,800.00
	Total Construction Cost	\$18,086,470.00	\$29,488,860.00

Notes:

- 1 All costs are priced in Q1 2026 dollars with no escalation allowance.
- 2 Post contract contingency included at 10%.
- 3 A 10% allowance is carried for site constraints for difficulty of work.
- 4 Assumed work is to be carried out during regular working hours.
- 5 General requirement costs include bonds, insurances, site staff, temporary measures, site trailers, trucks etc.
- 6 An allowance of 8% has been included for General Conditions, temporary measures, demobilization, etc.
- 7 Estimate assumes work to be procured through a general contractor and an allowance of 15% has been included for site supervision, temporary measures, fee etc.
- 8 Quantities provided in the estiamte are preliminary. They will be confirmed as the design progresses.
- 9 Estimate is based on receiving 3-6 general contractor bids.
- 10 Soft Costs are excluded. i.e. design consultants, permits, development charges etc.
- 11 Administration costs: project / development manger costs are excluded.
- 12 A Design / Estimating contingency allowance of 30% is included for undefined scope of work and market conditions.
- 13 The estimate excludes any costs associated with schedule and cost impacts to material supply or labour disruptions due to force majeure events. i.e. natural disasters, pandemics etc.
- 14 No allowance for the economic implications of new Tariffs that may affect future construction costs.



NOTL Irrigation Infrastructure
"Class 4" Construction Cost Estimate
Dee Road Pumping Station

#	Description	Quantity	Unit	Unit Rate	Total
<u>1</u>	G30 SITE CIVIL/MECHANICAL UTILITIES				
<u>3</u>	G2050 Landscaping				
<u>4</u>	G2057 Irrigation Systems				
<u>6</u>	Dee Road Pumping Station: Add third pump				
<u>7</u>	Wet Well:				
<u>8</u>	200HP vertical turbine pump, 5000gpm	1	no	\$173,569	\$173,570
<u>9</u>	Pump intake screen, 48" dia. x 140" long	1	no	\$99,500	\$99,500
<u>10</u>	Process piping	50	m	\$750	\$37,500
<u>11</u>	Instrumentation (ultrasound level transmitter, level floats)	1	sum	\$50,000	\$50,000
<u>12</u>	Equipment Installation	1	sum	\$180,300	\$180,300
<u>13</u>	Testing and commissioning	1	sum	\$90,100	\$90,100
<u>14</u>	Wet well structure	1	sum	\$600,000	\$600,000
<u>15</u>	Access hatches	2	no	\$5,000	\$10,000
<u>16</u>	Aluminum ladder and platform	1	sum	\$25,000	\$25,000
<u>17</u>	Excavation and backfill (wet well)	300	m³	\$50	\$14,980
<u>18</u>	Dewatering	1	sum	\$50,000	\$50,000
<u>20</u>	Valve Chamber:				
<u>21</u>	Process piping	20	m	\$750	\$15,000
<u>22</u>	Process valves (sluice gate valves, check valves, PRV, etc.)	1	sum	\$100,000	\$100,000
<u>23</u>	Instrumentation (flow meter, pressure transmitter)	1	sum	\$50,000	\$50,000
<u>24</u>	Other misc. (sum pump, temperature alarm, flood alarm, etc)	1	sum	\$25,000	\$25,000
<u>25</u>	Equipment Installation	1	sum	\$95,000	\$95,000
<u>26</u>	Testing and commissioning	1	sum	\$47,500	\$47,500
<u>27</u>	Valve chamber structure	1	sum	\$240,000	\$240,000
<u>28</u>	Access hatches	2	no	\$5,000	\$10,000
<u>29</u>	Excavation and backfill	60	m³	\$50	\$3,000
<u>30</u>	Dewatering	1	sum	\$10,000	\$10,000
<u>32</u>	Overflow Storage Tank:				
<u>33</u>	Instrumentation (ultrasound level transmitter, level floats)	1	sum	\$30,000	\$30,000
<u>34</u>	Equipment Installation	1	sum	\$15,000	\$15,000
<u>35</u>	Testing and commissioning	1	sum	\$7,500	\$7,500
<u>36</u>	Pre-cast concrete storage tank structure	1	sum	\$200,000	\$200,000
<u>37</u>	Access hatches	2	no	\$5,000	\$10,000
<u>38</u>	Excavation and backfill	2,000	m³	\$50	\$100,000
<u>39</u>	Dewatering	1	sum	\$100,000	\$100,000
<u>41</u>	Site Servicing:				
<u>42</u>	Bollards	5	no	\$2,000	\$10,000
<u>43</u>	Yard piping & trenching	100	m	\$1,500	\$150,000
<u>44</u>	Electrical duct bank & trenching	50	m	\$1,000	\$50,000
<u>45</u>	Site Grading	1	sum	\$100,000	\$100,000
<u>46</u>	Asphalt road	100	m²	\$100	\$10,000
<u>47</u>	Construction material testing	1	sum	\$20,000	\$20,000
<u>48</u>	Security fence	200	m	\$200	\$40,000
<u>49</u>	Entrance gate	1	no	\$10,000	\$10,000
<u>50</u>	Sedimentation and erosion control	1	sum	\$25,000	\$25,000
<u>51</u>	Mobilization and demobilization	1	sum	\$50,000	\$50,000
<u>53</u>	Control Building:				
<u>54</u>	Power transformer	1	no	\$20,000	\$20,000
<u>55</u>	Power distribution panel	1	no	\$50,000	\$50,000
<u>56</u>	PLC control panel	1	no	\$80,000	\$80,000
<u>57</u>	Pump RVSS starter panel (600V, 200 HP)	1	no	\$50,000	\$50,000
<u>58</u>	Other Misc. (wire, duct, terminal blocks, circuit breakers, relays etc..)	1	sum	\$40,000	\$40,000
<u>59</u>	HVAC (electrical heaters and inline ventilator)	1	sum	\$20,000	\$20,000
<u>60</u>	Equipment installation	1	sum	\$130,000	\$130,000
<u>61</u>	Testing and commissioning	1	sum	\$65,000	\$65,000
<u>62</u>	SCADA Integration	1	sum	\$100,000	\$100,000
<u>63</u>	Pre-cast control building	1	sum	\$75,000	\$75,000



NOTL Irrigation Infrastructure
"Class 4" Construction Cost Estimate
Dee Road Pumping Station

#	Description	Quantity	Unit	Unit Rate	Total
<u>65</u>	Outdoor Generator:				
<u>66</u>	Backup generator (150 KW, 600V)	1	no	\$100,000	\$100,000
<u>67</u>	Automatic transfer switch	1	no	\$50,000	\$50,000
<u>68</u>	Equipment Installation	1	sum	\$75,000	\$75,000
<u>69</u>	Testing and Commissioning	1	sum	\$37,500	\$37,500
<u>70</u>	Generator pad	1	sum	\$15,000	\$15,000
<u>72</u>	Pipework				
<u>73</u>	Road crossings	2	no		
<u>74</u>	Directional drilling	30	m	\$12,000	\$360,000
<u>75</u>	Pit for directional drilling	4	m²		Included
<u>76</u>	Equipment mob and demob	2	sum	\$5,000	\$10,000
<u>77</u>	No allowance for rock blasting				Excluded
<u>79</u>	Major road crossings, ~25m	1	no		
<u>80</u>	Directional drilling	30	m	\$12,000	\$360,000
<u>81</u>	Pit for directional drilling	2	m²		Included
<u>82</u>	Equipment mob and demob	1	sum	\$5,000	\$5,000
<u>83</u>	No allowance for rock blasting				Excluded
<u>85</u>	Water courses crossed	3	no		
<u>86</u>	Waterway protection	3	no	\$15,000	\$45,000
<u>88</u>	Bends, 22.5 deg or more	2	no	\$2,500	\$5,000
<u>90</u>	Asphalt above watermain crossings	2,565	m		
<u>91</u>	Remove & dispose of paved road surface	5,130	m²	\$3	\$15,390
<u>92</u>	Remove & dispose of existing subgrade	5,130	m²	\$9	\$46,170
<u>93</u>	Supply and place subgrade	9,171	ton	\$38	\$348,490
<u>94</u>	Supply and place 50mm thick HL8 asphalt	745	ton	\$230	\$171,390
<u>95</u>	Supply and place 40mm thick HL3 asphalt	648	ton	\$170	\$110,150
<u>97</u>	Hydrovac allowance at utility crossing	20	no	\$4,000	\$80,000
<u>98</u>	Utility crossings (hydro)	11	no		Included
<u>99</u>	Utility crossings (gas)	5	no		Included
<u>100</u>	Utility crossings (bell/cogeco)	4	no		Included
<u>102</u>	Hydrovac allowance at drain crossing	3	no	\$4,000	\$12,000
<u>103</u>	Municipal drain crossings	3	no		Included
<u>105</u>	South side roads	2	no		\$0
<u>106</u>	Directional drilling	30	m	\$12,000	\$360,000
<u>107</u>	Pit for directional drilling	4	m²		Included
<u>108</u>	Equipment mob and demob	2	sum	\$5,000	\$10,000
<u>109</u>	No allowance for rock blasting				Excluded
<u>111</u>	Driveway crossings	20	no		
<u>112</u>	Saw cut driveway	20	no	\$1,280	\$25,600
<u>113</u>	Restore driveway	20	no	\$1,500	\$30,000
<u>114</u>	Restore asphalt driveway approaches	360	m²	\$98	\$35,280
<u>116</u>	Outlet manhole valve and wier	4	no	\$14,000	\$56,000
<u>117</u>	Future tees and valve	2	no	\$5,000	\$10,000
<u>118</u>					
<u>119</u>	Pipe, existing to Harrison, 750mm	990	m	\$700	\$693,000
<u>120</u>	Pipe, Harrison to Four Mile Creek, 375mm	2,225	m	\$400	\$890,000
<u>121</u>	Pipe, Dee to Harrison, 800mm	2,085	m	\$650	\$1,355,250
<u>122</u>	Pipe, Harrison to Four Mile Creek, 450mm	2,225	m	\$450	\$1,001,250
<u>124</u>	Reinstate and seed disturbed area	15,050	m²	\$10	\$150,500
<u>126</u>	Excavation and backfill for pipework				Included
128	Sub Total				\$9,946,900



NOTL Irrigation Infrastructure
"Class 4" Construction Cost Estimate
Eastchester Pumping Station

#	Description	Quantity	Unit	Unit Rate	Total
<u>1</u>	G30 SITE CIVIL/MECHANICAL UTILITIES				
<u>3</u>	G2050 Landscaping				
<u>4</u>	G2057 Irrigation Systems				
<u>6</u>	Eastchester Pumping Station: Add pumps				
<u>7</u>	<u>Wet Well:</u>				
<u>8</u>	Vertical turbine pump, 4000gpm	3	no	\$152,700	\$458,100
<u>9</u>	Pump intake screen, 42" dia. x 158" long	1	no	\$237,000	\$237,000
<u>10</u>	Airburst, 660gal receiver	1	no	\$86,615	\$86,620
<u>11</u>	Process piping	150	m	\$750	\$112,500
<u>12</u>	Instrumentation (ultrasound level transmitter, level floats)	1	LS	\$80,000	\$80,000
<u>13</u>	Equipment Installation	1	sum	\$487,100	\$487,100
<u>14</u>	Testing and commissioning	1	sum	\$243,600	\$243,600
<u>15</u>	Wet well structure	3	sum	\$525,000	\$1,575,000
<u>16</u>	Access hatches	3	no	\$5,000	\$15,000
<u>17</u>	Aluminum ladder and platform	3	sum	\$25,000	\$75,000
<u>18</u>	Excavation and backfill (wet well)	788	m³	\$50	\$39,380
<u>19</u>	Dewatering	1	sum	\$100,000	\$100,000
<u>21</u>	<u>Valve Chamber:</u>				
<u>22</u>	Process piping	50	m	\$750	\$37,500
<u>23</u>	Process valves (sluice gate valves, check valves, PRV, etc.)	1	sum	\$200,000	\$200,000
<u>24</u>	Instrumentation (flow meter, pressure transmitter)	1	sum	\$100,000	\$100,000
<u>25</u>	Other misc. (sum pump, temperature alarm, flood alarm, etc)	1	sum	\$60,000	\$60,000
<u>26</u>	Equipment Installation	1	sum	\$198,800	\$198,800
<u>27</u>	Testing and commissioning	1	sum	\$99,400	\$99,400
<u>28</u>	Valve chamber structure	3	sum	\$240,000	\$720,000
<u>29</u>	Access hatches	6	no	\$5,000	\$30,000
<u>30</u>	Excavation and backfill	180	m³	\$50	\$9,000
<u>31</u>	Dewatering	1	sum	\$20,000	\$20,000
<u>33</u>	<u>Overflow Storage Tank:</u>				
<u>34</u>	Instrumentation (ultrasound level transmitter, level floats)	1	sum	\$50,000	\$50,000
<u>35</u>	Equipment Installation	1	sum	\$25,000	\$25,000
<u>36</u>	Testing and commissioning	1	sum	\$12,500	\$12,500
<u>37</u>	Pre-cast concrete storage tank structure	1	sum	\$300,000	\$300,000
<u>38</u>	Access hatches	4	no	\$5,000	\$20,000
<u>39</u>	Excavation and backfill	3,000	m³	\$50	\$150,000
<u>40</u>	Dewatering	1	sum	\$150,000	\$150,000
<u>42</u>	<u>Site Servicing:</u>				
<u>43</u>	Bollards	15	ea	\$2,000	\$30,000
<u>44</u>	Yard piping & trenching	200	m	\$1,500	\$300,000
<u>45</u>	Electrical duct bank & trenching	100	m	\$1,000	\$100,000
<u>46</u>	Site Grading	1	sum	\$150,000	\$150,000
<u>47</u>	Asphalt road	200	m²	\$100	\$20,000
<u>48</u>	Construction material testing	1	sum	\$50,000	\$50,000
<u>49</u>	Security fence	300	m	\$200	\$60,000
<u>50</u>	Entrance gate	1	no	\$10,000	\$10,000
<u>51</u>	Sedimentation and erosion control	1	sum	\$50,000	\$50,000
<u>52</u>	Mobilization and demobilization	1	sum	\$50,000	\$50,000
<u>54</u>	<u>Control Building:</u>				
<u>55</u>	Power transformer	1	ea	\$20,000	\$20,000
<u>56</u>	Power distribution panel	1	ea	\$50,000	\$50,000
<u>57</u>	PLC control panel	1	ea	\$80,000	\$80,000
<u>58</u>	Pump RVSS starter panel (600V, 160 HP)	3	ea	\$40,000	\$120,000
<u>59</u>	Other Misc. (wire, duct, terminal blocks, circuit breakers, relays etc..)	1	sum	\$80,000	\$80,000
<u>60</u>	HVAC (electrical heaters and inline ventilator)	1	sum	\$30,000	\$30,000
<u>61</u>	Equipment installation	1	sum	\$190,000	\$190,000
<u>62</u>	Testing and commissioning	1	sum	\$95,000	\$95,000
<u>63</u>	SCADA Integration	1	sum	\$100,000	\$100,000
<u>64</u>	Pre-cast control building	1	sum	\$75,000	\$75,000



NOTL Irrigation Infrastructure
"Class 4" Construction Cost Estimate
Eastchester Pumping Station

#	Description	Quantity	Unit	Unit Rate	Total
<u>66</u>	<u>Outdoor Generator:</u>				
<u>67</u>	Backup generator (350 KW, 600V)	1	ea	\$230,000	\$230,000
<u>68</u>	Automatic transfer switch	1	ea	\$100,000	\$100,000
<u>69</u>	Equipment Installation	1	sum	\$165,000	\$165,000
<u>70</u>	Testing and Commissioning	1	sum	\$82,500	\$82,500
<u>71</u>	Generator pad	1	sum	\$20,000	\$20,000
<u>73</u>	<u>Pipework</u>				
<u>74</u>	Road crossings	6	no		
<u>75</u>	Directional drilling	90	m	\$12,000	\$1,080,000
<u>76</u>	Pit for directional drilling	12	m ²		Included
<u>77</u>	Equipment mob and demob	6	sum	\$5,000	\$30,000
<u>78</u>	No allowance for rock blasting				Excluded
<u>80</u>	Major road crossings, ~25m	2	no		
<u>81</u>	Directional drilling	60	m	\$12,000	\$720,000
<u>82</u>	Pit for directional drilling	4	m ²		Included
<u>83</u>	Equipment mob and demob	2	sum	\$5,000	\$10,000
<u>84</u>	No allowance for rock blasting				Excluded
<u>86</u>	Water courses crossed	4	no		
<u>87</u>	Waterway protection	4	no	\$15,000	\$60,000
<u>89</u>	Bends, 22.5 deg or more	5	no	\$2,500	\$12,500
<u>91</u>	Asphalt above watermain crossings	3,960	m		
<u>92</u>	Remove & dispose of paved road surface	7,920	m ²	\$3	\$23,760
<u>93</u>	Remove & dispose of existing subgrade	7,920	m ²	\$9	\$71,280
<u>94</u>	Supply and place subgrade	14,159	ton	\$38	\$538,030
<u>95</u>	Supply and place 50mm thick HL8 asphalt	1,150	ton	\$230	\$264,610
<u>96</u>	Supply and place 40mm thick HL3 asphalt	1,000	ton	\$170	\$170,050
<u>98</u>	Hydrovac allowance at utility crossing	12	no	\$4,000	\$48,000
<u>99</u>	Utility crossings (hydro)	6	no		Included
<u>100</u>	Utility crossings (gas)	1	no		Included
<u>101</u>	Utility crossings (bell/cogeco)	5	no		Included
<u>103</u>	Hydrovac allowance at drain crossing	8	no	\$4,000	\$32,000
<u>104</u>	Municipal drain crossings	8	no		Included
<u>106</u>	South side roads	6	no		\$0
<u>107</u>	Directional drilling	90	m	\$12,000	\$1,080,000
<u>108</u>	Pit for directional drilling	12	m ²		Included
<u>109</u>	Equipment mob and demob	6	sum	\$5,000	\$30,000
<u>110</u>	No allowance for rock blasting				Excluded
<u>112</u>	Driveway crossings	25	no		
<u>113</u>	Saw cut driveway	25	no	\$1,280	\$32,000
<u>114</u>	Restore driveway	25	no	\$1,500	\$37,500
<u>115</u>	Restore asphalt driveway approaches	450	m ²	\$98	\$44,100
<u>117</u>	Outlet manhole valve and wier	7	no	\$14,000	\$98,000
<u>118</u>	Future tees and valve	6	no	\$5,000	\$30,000
<u>120</u>	Pipe, Eastchester to NOTL wier 004, 800mm	3,200	m	\$735	\$2,352,000
<u>121</u>	Pipe, NOTL wier 004 to 005, 600mm	340	m	\$600	\$204,000
<u>122</u>	Pipe, NOTL wier 005 to Bright, 500mm	240	m	\$520	\$124,800
<u>123</u>	Pipe, Bright to Four Mile Creek, 250mm	3,220	m	\$120	\$386,400
<u>125</u>	Reinstate and seed disturbed area	14,000	m ²	\$10	\$140,000
<u>127</u>	Excavation and backfill for pipework				Included
129	Sub Total				\$15,568,000