REQUEST FOR PROPOSALS
(RFP)

SEWER LIFT STATION REPLACEMENT
AT
RUSCH COMMUNITY PARK
7801 Auburn Blvd.
Citrus Heights, CA 95621

Deadline for Submission:
July 24, 2024, at 11:00am

Under no circumstances will late proposals be accepted

Sunrise Recreation and Park District (SRPD)
7801 Auburn Blvd.
Citrus Heights, CA 95610

TO: Prospective Bidders

FROM: Kevin Huntzinger, District Administrator

DATE: Wednesday, June 12, 2024

RE: BID PROPOSALS FOR SEWER LIFT STATION REPLACMENT AT RUSCH COMMUNITY PARK

INVITATION FOR PROPOSALS

The Sunrise Recreation and Park District (SRPD) is seeking an experienced professional contractor to provide services for the replacement of two sanitary sewer pumps and associated electrical and control equipment.

Parties interested in this project are asked to submit one (1) copy of the proposal no later than 11:00am on July 24, 2024, to:

Wayne Edmundson
Sunrise Recreation and Park District
7801 Auburn Blvd.
Citrus Heights, Ca 95610

SRPD reserves the right to reject any or all proposals, to waive any technicalities, informalities, and irregularities, to accept or reject all or any part of the proposal, and to be the sole judge of suitability on the proposal offer.

PROJECT BACKGROUND

The sanitary sewer lift station at Rusch Community Park experiences frequent clogging. The lift station consists of a 4-foot diameter by 6-foot-deep fiberglass wet well. It has two (2) Crane submersible grinder pumps – one duty and one backup. Each pump requires 2 horsepower and 240 volts of electrical service. The lift station has a three-float system to call on and off the pumps and send a high-water alarm.

SCOPE OF WORK

The scope of work, in general, includes the following tasks but not limited to:

To mitigate the clogging issue, SRPD would like to replace their impeller pumps with the product referenced in Appendix B. SRPD has ordered these pumps and they will be delivered directly to the project site. This transition will also require an upgrade to the power supply. The selected contractor shall be responsible for the following:

- Demo of existing electrical and lift station control panels

- Provide and install new 60-amp 230-volt single phase feed

- Provide and install (2) new variable frequency drives, associated wiring, and control panel. Specifications include:

    - Single phase 230V to Three Phase 230 V conversion control panel to include:
        - NEMA 4 enclosure with inner door
        - Main circuit breaker with door interlocking handle
        - Motor protector VFD starters
        - (2) ABB ACQ580 3 HP VFDs
        - Control power transformer
        - Transformer primary fuse protection
        - HAND-OFF-AUTO selector switches
        - Terminals for all field wiring connections
        - Ventilation fans
        - Surge arrestor
        - 3 float control (off, on, lag/high level)
        - Run indicator
        - Elapsed time meter
        - MiniCAS seal failure relay and indicators
        - Motor over temp indicators
        - Alarm Light and Horn with push to silence
    - Startup Assistance (1 day)
    - 2 ACQ580 Water/Wastewater drive – supply voltage at 240 VAC One Phase. 9.6 Rated Output Amps (3HP), UL (NEMA) Type 1, Frame Size- R2 (installed in control panel by integrator)
    - 2 Keypad Mounting Kits (installed in control panel by integrator)
    - 2 Flygt MiniCAS moisture and thermal protection relays (installed in control panel by integrator)

- Upsizing of plumbing in vault from 2”-3” to fit new Flygt pumps

- Removing and replacing the existing pumps with the Flygt Non-Clog Impeller Pumps with N-Impellers (See Appendix B for product specifications). New pumps have been ordered by SRPD and will be delivered directly to the job site.

See Appendix A for plumbing site plan
See Appendix B for equipment specifications

<u>EXISTING CONDITIONS</u>
The vendor, in undertaking the work under this contract, is to have visited the premises and to have taken into consideration all conditions which might affect the work. No consideration will be given to any claims based on lack of knowledge of existing conditions. The **mandatory** Pre-Bid walk date is scheduled for June 19, 2024, at 9:00am.

DEVIATIONS
Any deviations from the scope of work indicated herein must be submitted in writing to the project manager prior to the bid due date.

CHANGE ORDERS
Change orders will not be considered once the proposed bid has been accepted.

VALID CALIFORNIA CONTRACTOR'S LICENSE – Required at time of bid submission and valid through the length of the project.

PREVAILING WAGE - Pursuant to the California Labor Code Section 1720 and following this is a prevailing wage project.

DIR REGISTRATION - All contractors and subcontractors must register with the DIR and meet DIR requirements before bidding on public works contracts in California.

SUBMITTALS - The successful bidder shall be required to execute a Material and Labor Payment Bond and Performance Bond issued by a corporate surety, acceptable to the Sunrise Recreation and Park District, for the SEWER LIFT STATION REPLACEMENT AT RUSCH COMMUNITY PARK. Each bond shall not be less than one hundred percent (100%) of that portion of the contract price.

Pursuant to California Contract Code Section 22300, the contractor may, at its own expense, substitute securities for any money being withheld by the County to ensure performance under this contract.

QUESTIONS - Please direct pre-bid questions in writing to:

Wayne Edmundson
Sunrise Recreation and Park District, by e-mail at:
wedmundson@sunriseparks.com
Deadline for questions is 11:00 AM on July 3, 2024.

Addendums and answers to all questions will be posted on the District Website by 5:00 PM on Wednesday July 10, 2024. It is the Contractors\ responsibility to check the District Website (www.sunriseparks.com) for updates.

The Board reserves the right to reject any or all bids, to waive any informality in any bid, and to determine which bid, in the judgment of the Board, is the lowest responsive bid of a responsible bidder.

Kevin Huntzinger
District Administrator
Sunrise Recreation and Park District

NOTICE TO CONTRACTORS

Notice is hereby given that the Sunrise Recreation and Park District of Sacramento County, California, will receive bids as follows:

RFP RELEASE DATE:	**June 12, 2024**
FOR:	**CONTRACT NO. 2024-06-RPCP** **SEWER LIFT STATION REPLACEMENT AT RUSCH COMMUNITY PARK**

MANDATORY PRE-BID WALK DATE AND TIME:

	June 19, 2024 @ 9:00 AM AT THE RUSCH COMMUNITY PARK
SUBMIT QUESTIONS BY AND TO:	**July 3, 2024 @ 11:00 AM** **wedmundson@sunriseparks.com**
BID DUE DATE AND TIME:	**ON OR BEFORE 11:00 AM** **July 24, 2024**
SUBMIT BIDS TO:	**Wayne Edmundson via Email To** **wedmundson@sunriseparks.com**
BID OPENING:	**July 24, 2024 @ 1:00 PM**

PROPOSAL - BID FORM
CONTRACT NO. 2024-06-RPCP

I. BID:

Pursuant to your published NOTICE TO CONTRACTORS for the above-referenced project, and in accordance with the approved Scope (page 2 and 3 of RFP, and any addendums posted to District website) for that project, the following bid for said entire project is hereby submitted by the firm indicated in Part V (Contractor Information) of this Bid Form.

BASE BID:

BID ITEM	ITEM DESCRIPTION	UNITS OF MEASURE	AMOUNT (IN FIGURES)
1	Pump installation with specified product, provide additional required electrical upgrades and installation of variable frequency drive.	LUMP SUM	

TOTAL BASE BID:
SUM OF ALL ITEMS BASE BID AMOUNT $____________________

Notes:

1. Bidders must submit bids for each item. If a bid is missing a price, then the bid may be deemed incomplete and the bid may be rejected as non-responsive.
2. The Sunrise Recreation and Park District intends to award the contract to the lowest responsible, responsive bidder based on the lowest Base Bid. The District reserves the right to reject any and all bids offered in response to this RFP, and either re-bid or take any other action permitted by statute.
3. If a bid is missing a Lump Sum Amount, Unit Cost or an Extended Cost, then the bid will be deemed incomplete and the bid **may be rejected** as non-responsive.
4. In the event the product of a unit cost and an extended cost do not equal the extended cost stated, the unit cost will govern and the correct product of the unit cost and the Estimated Quantity shall be deemed to be the amount bid.

II. AFFIDAVIT OF NONCOLLUSION:

The bidder swears and deposes that he or she is the party making the foregoing bid, that the bid is not made in the interest of, or on behalf of, any undisclosed person, partnership, company, association, organization, or corporation; that the bid is genuine and not collusive for sham; that the bidder has not directly or indirectly induced or solicited any other bidder to put in a false or sham bid, and has not directly or indirectly colluded, conspired, connived, or agreed with any bidder or anyone else to put in a sham bid, or that anyone shall refrain from bidding; that the bidder has not in any manner, directly or indirectly, sought by agreement, communication or conference with anyone to fix the bid price of the bidder or any other bidder, or to fix any overhead, profit, or cost element of the bid price, or of that of any other bidder, or to secure any advantage against the public body awarding the contract of anyone interested in the proposed contract; that all statements contained in the bid are true; and, further that the bidder has not, directly or indirectly, submitted his or her bid price or any breakdown thereof, or the contents thereof, or divulged information or data relative thereto, or paid, and will not pay, any fee to any corporation, partnership, company, association, organization, bid depository or to any member or agent thereof to effectuate a collusive or sham bid.

III. SUBCONTRACTOR LISTING:

In accordance with the California Public Contract Code, Division 2, Part 1, Chapter 4, Section 4100, and following, the subcontractors listed on the Bid Form will perform the indicated work of improvement on the project.

IV. TYPE OF BUSINESS (Check One):

[ ] CORPORATION STATE OF INCORPORATION___________

[ ] PARTNERSHIP

[ ] JOINT VENTURE

[ ] PRIVATE INDIVIDUAL

[ ] INDIVIDUAL DOING BUSINESS UNDER A FIRM NAME

V. CONTRACTOR INFORMATION

Firm Name ____

NOTE: In addition, place name on each Bid Sheet where space is provided

Address ____

____

Email ____

Telephone (   )________________________ Fax (   )____________________

Contractor's License Number ____________________________________

Contractor's License Expiration Date ______________________________

Contractor's License Classification(s) _____________________________

Contractor's California DIR Number ______________________________

I HEREBY CERTIFY UNDER PENALTY OF PERJURY THAT THE ABOVE STATEMENTS ARE TRUE.

BID AND CERTIFICATION SUBMITTED _________________________________
DATE

SIGNATURE ____
AUTHORIZED REPRESENTATIVE

____
PRINT OR TYPE NAME

TITLE ____

SUBMIT THIS SHEET WITH YOUR BID

FIRM NAME______________________________ **PROJECT NO. 2024-06-RPCP**

VI. DESIGNATION OF SUBCONTRACTORS

In accordance with the Public Contract Code, Part 1, Chapter 4, Subletting and Subcontracting, bidders must list the names and location of places of business of all subcontractors who will perform work or labor or render service to the bidder in an amount in excess of one-half of one percent (0.5%) of the total bid. Refer to Section 2-8 of the Standard Construction Specifications.

The apparent low bidder must submit a listing of license numbers for all subcontractors within three days, not counting Saturdays, Sundays, and holidays, of bid opening. If the low bidder is not the apparent low bidder, the apparent low bidder shall submit the license numbers of all listed subcontractors to the Agency within three days not counting Saturdays, Sundays, and holidays, of the date notified.

If the percentage of the work is not filled out, it will be assumed that the sub is responsible for 100% of the line items related to his trades work.

PERCENT PERFORMED/TYPE OF WORK	SUBCONTRACTOR'S NAME	BUSINESS LOCATION CITY, STATE

(USE ADDITIONAL SHEETS IF NECESSARY)

SUBMIT THIS SHEET WITH YOUR BID

VII. <u>DELIVERY DATE</u>

Date of completion of the project must be by February 28, 2025

VIII. <u>WARRANTY FOR BASE BID ITEMS</u>

List the warranty specifications for all base bid items:

____

____

____

____

SIGNATURE ____
AUTHORIZED REPRESENTATIVE

____
PRINT OR TYPE NAME

TITLE ____

IX. **LABOR COMPLIANCE** – This is a "construction" project in accordance with Section 1771.5 of the California Labor Code. "Prevailing Wage Requirements" will apply.

Pursuant to the California Labor Code Section 1720 and following, and Section 1770 and following, the successful bidder shall pay not less than the prevailing rate of per diem wages as determined by the Director of the California Department of Industrial Relations. Wage schedules may be downloaded at the DIR website: http://www.dir.ca.gov/dlsr/DPreWageDetermination.htm

X. **INSURANCE** – Before beginning any work, the contractor shall furnish or have on file, satisfactory certificates of insurance. The certificates must be held by the Sunrise Recreation and Park District, a special district of Sacramento County and must remain in effect for the duration of the contract.

CONTRACTOR shall maintain limits no less than:
General Liability shall be on an Occurrence basis (as opposed to Claims Made basis). Minimum limits and structure shall be:

Building Trades General Aggregate:	$2,000,000
Products Comp/Op Aggregate:	$2,000,000
Personal & Adv. Injury:	$1,000,000
Each Occurrence:	$1,000,000
Fire Damage:	$ 100,000

CONTRACTORS and CONTRACTORS engaged in other projects of construction shall have their general liability Aggregate Limit of Insurance endorsed to apply separately to each job site or project, as provided for by Insurance Services Office form CG-2503 Amendment-Aggregate Limits of Insurance (Per Project).

AUTOMOBILE LIABILITY:

Commercial Automobile Liability for Corporate/business owned vehicles including non-owned and hired, $1,000,000 Combined Single Limit.

Personal Lines Automobile Liability for Individually owned vehicles, $250,000 per person, $500,000 each accident, $100,000 property damage.

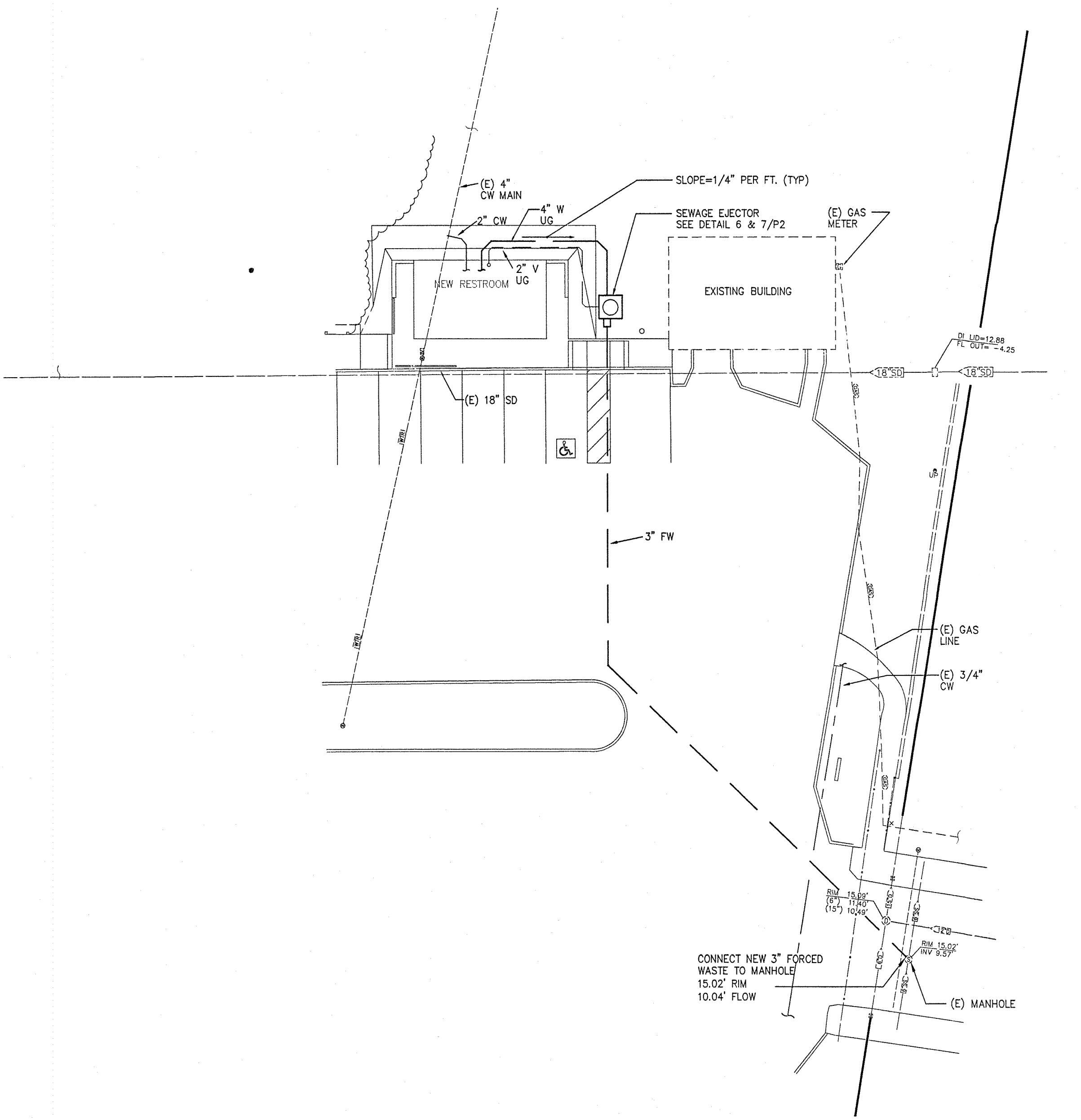
Firm agrees to provide a certificate of insurance before beginning any work.

SIGNATURE ____
AUTHORIZED REPRESENTATIVE

____
PRINT OR TYPE NAME

TITLE ____

APPENDIX A - PLUMBING SITE PLAN



PLUMBING SITE PLAN 1

1/16" = 1'-0"

HCA

HANSEN Consulting Architects
6503 Grant Avenue
Carmichael, CA 95608
TEL/FAX 916.944.8236

REGISTERED PROFESSIONAL ENGINEER
ROBERT PATRICK WICHERT
No. 21652
MECHANICAL
STATE OF CALIFORNIA

Consultant
KC ENGINEERING
6320 BELLEAU WOOD LANE SUITE #2
Sacramento, CA 95822
TEL 916.429.8213

Sunrise RECREATION & PARK DISTRICT

RUSCH PARK RESTROOM

SUNRISE RECREATION and PARK DISTRICT
7801 Auburn Boulevard
Citrus Heights, CA

REVISIONS:

JOB #: 0203.01

DRAWN BY: KV

DATE: 1 AUGUST 2002

SCALE: As Noted

FILE: p1.dwg

SHEET #

P1

Plumbing Site & Floor Plans

OF 12

xylem
Let's Solve Water

The Flygt N-technology pump series for water and wastewater

HIGH EFFICIENCY WITH CLOG-FREE PERFORMANCE

FLYGT
a xylem brand

No clogging. No wasted energy. Just trouble-free pumping

Our Flygt N-pumps (2.2hp - 870hp) are designed to handle the world's toughest water and wastewater applications. And now, with our Adaptive N™ technology in all smaller pumps, you get a superior way to avoid clogging, reduce unplanned maintenance and cut your energy bills. That adds up to total peace of mind – and big savings over the long term.

Our vast fluid handling knowledge and dedication to research and development leads to technological advances and continuous improvement. That's why Flygt N-pumps are currently at work in millions of installations worldwide. Quite simply, they have proven to be the best and most reliable choice for both dry and submersible installations.

Sustained high efficiency saves money

When solid objects, such as stringy fibers and modern waste, enter the inlet of a conventional pump, they tend to get caught on the leading edges of the impeller vanes. This build-up reduces the impeller's efficiency, resulting in increased power consumption (Fig. A).

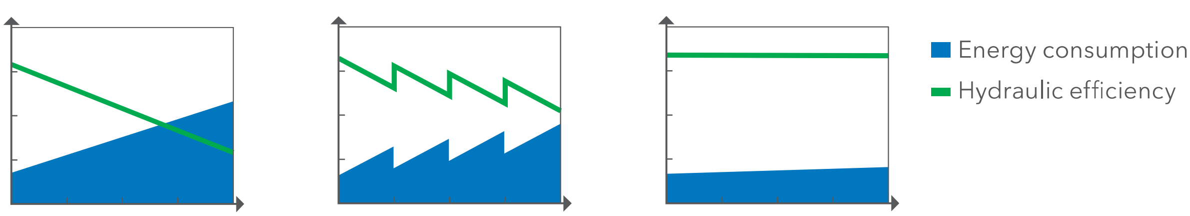
Avoiding unplanned service calls

With conventional wastewater pumps, a continued build-up of solids inside the impeller can trip the panel overload or motor protection function, causing clogging and leading to costly unplanned service calls (Fig. A). Even if the pump is running intermittently, hydraulic efficiency is reduced since the solids build-up needs to be removed by backflushing when the pump is shut off at the end of the operating cycle (Fig. B). Not until the next cycle begins is efficiency restored to its initial value when the impeller is free from solid objects. The Flygt N-technology has a mechanically self-cleaning design that handles the toughest modern wastewater challenges. With sustained high efficiency it minimizes running hours and energy cost over time (Fig. C).

Experience the power of N

Whether you are working with wastewater, stormwater or another application, you will find a broad range of N-pumps designed to take on the toughest challenges and get the job done. Robust, reliable and self-cleaning, they cut your energy bills and virtually eliminate unplanned maintenance.

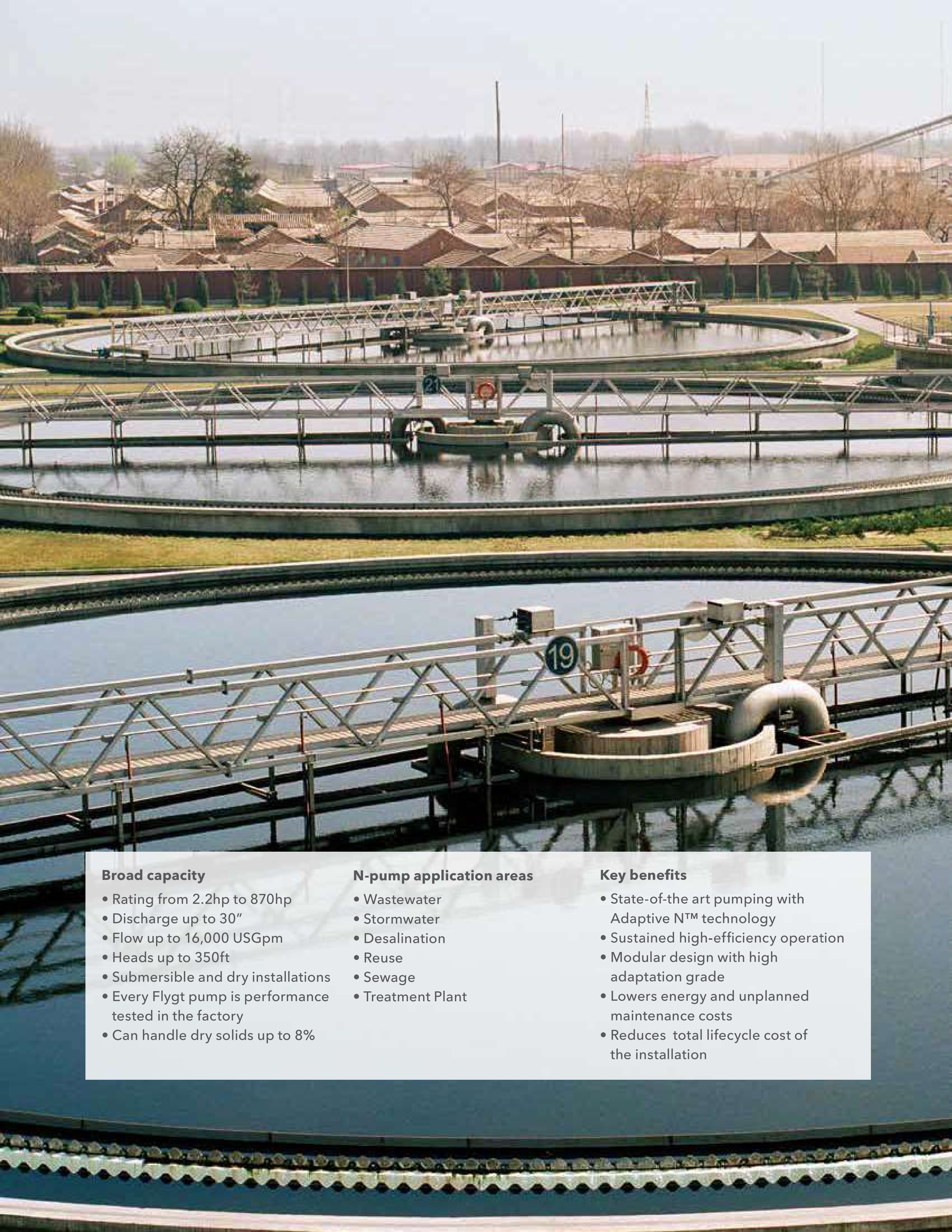
Sustained high efficiency with Flygt N-pumps



A. Conventional wastewater pump

B. Conventional pump running intermittently

C. Flygt N-pump



Broad capacity

- Rating from 2.2hp to 870hp
- Discharge up to 30″
- Flow up to 16,000 USGpm
- Heads up to 350ft
- Submersible and dry installations
- Every Flygt pump is performance tested in the factory
- Can handle dry solids up to 8%

N-pump application areas

- Wastewater
- Stormwater
- Desalination
- Reuse
- Sewage
- Treatment Plant

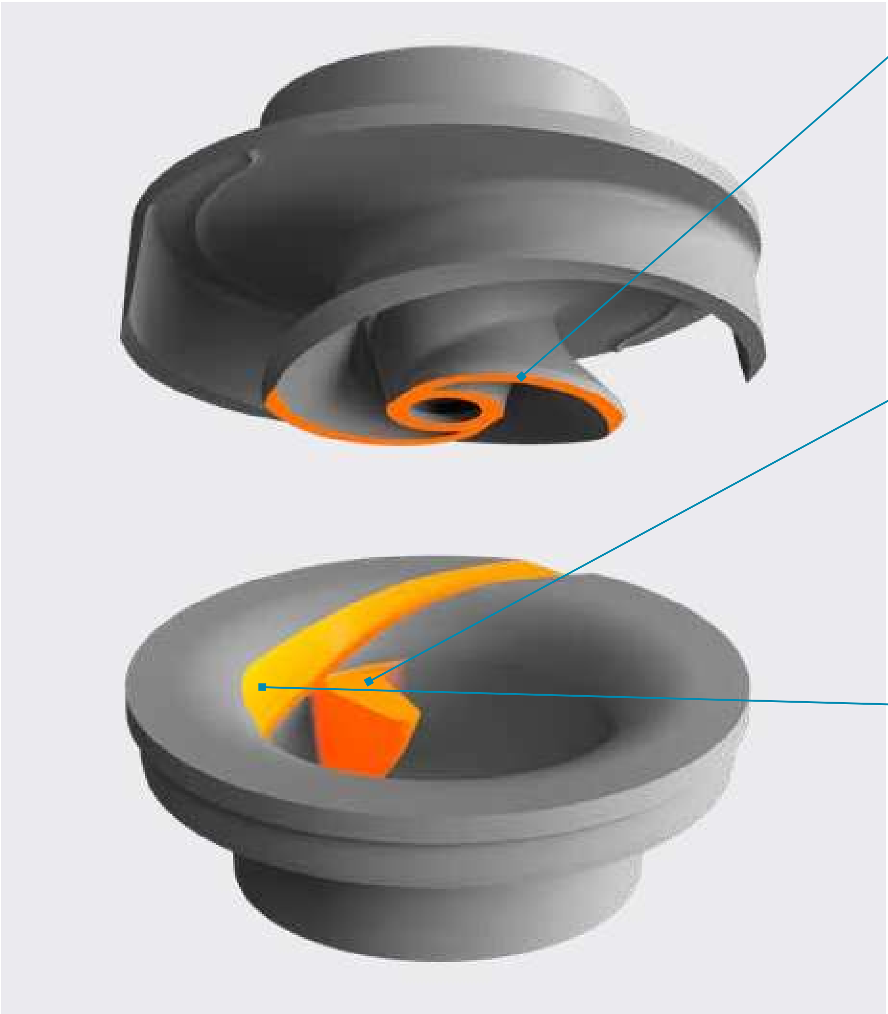
Key benefits

- State-of-the art pumping with Adaptive N™ technology
- Sustained high-efficiency operation
- Modular design with high adaptation grade
- Lowers energy and unplanned maintenance costs
- Reduces total lifecycle cost of the installation

Advanced technology guides the design of every component

From the motor and seals to the shaft and impellers, every component in a Flygt N-pump is designed, engineered and manufactured to optimize operation and prolong service life. Advanced technology guides the design of all aspects of the pump. One example is the Adaptive N hydraulic system, which is available only with lower-capacity pumps.

The fundamental N-technology, which was pioneered by Flygt, has been incorporated into our pumps for years. A more recent innovation is our Adaptive N impeller and Adaptive N hydraulic technologies (see below) which combine a unique geometry, dual-blade impeller and other patented features to give you sustained high efficiency and smooth operations. When larger objects enter the pump, the impeller lifts up due to the forces from these solid obects passing through. This self-cleaning design results in up to 25% lower energy consumption, regardless of impeller speed or duty point. It also minimizes vibrations, resulting in a longer life span for the mechanical components.

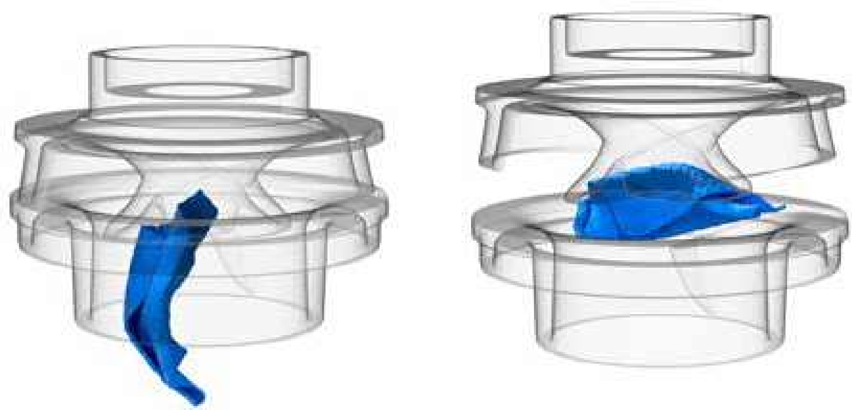


1. Backswept leading edges – ensures no sticking
When solids enter the pump, they are met by the N impeller. The optimized blade geometry, with its backswept leading edges, ensures that no material sticks to the impeller.

2. Integrated guide pin – clears the center
A guide pin inserted into the insert ring clears the center of the impeller by pushing solids along the leading edges towards the periphery of the impeller for removal.

3. Relief groove – facilitates transport
When solids reach the perimeter of the inlet, they are transported inside the relief groove, guided along the edge of the impeller vane, through the volute and out of the pump.

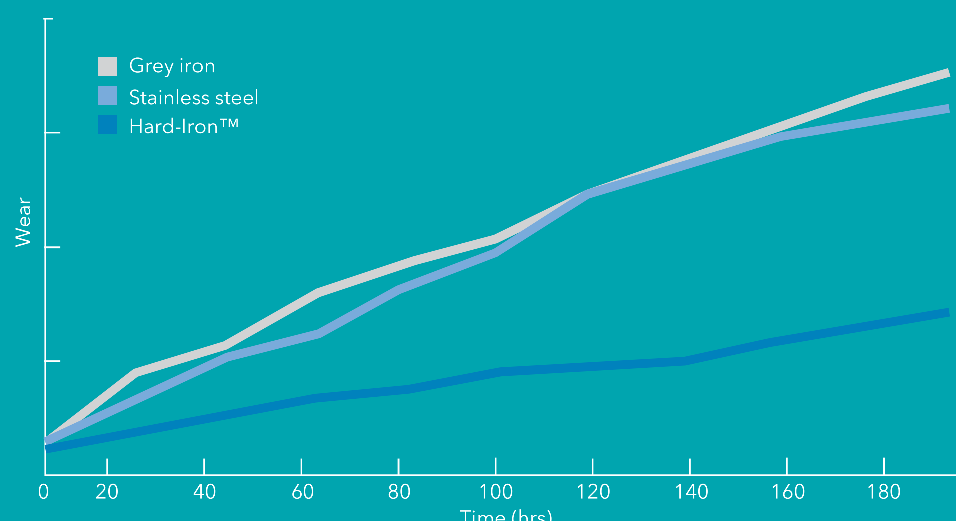
Adaptive N – lifts up for large objects
When larger objects enter the pump, the impeller lifts up due to the forces from these solid objects passing through. This avoids clogging and assures continuous, energy-efficient pumping.



Choice of impeller materials
With our Adaptive N impeller, you can also choose the optimal material type for your needs: Hard-Iron™, or stainless steel. Flygt's patented Hard-Iron alloy is developed specifically for tough wastewater applications. Accelerated wear tests prove that Hard-Iron (60 HRC) hydraulic components prolong the lifetime by a factor of five, compared to standard grey iron material.

Extra-durable option for abrasive and erosion corrosion applications.

Chopper ring for cutting long fibers or solids.



After 200 hours, the Hard-Iron impeller proved to be five times more wear resistant than the grey iron version. The stainless steel impeller showed wear comparable to the standard grey iron material.

Low-capacity pumps

This series of Flygt N-pumps includes models capable of handling capacities up to 1500 USGpm. Like all Flygt N-pumps, they help reduce the total life-cycle costs of your installation.

1. Better heat transfer
Our specially designed and manufactured motor provides enhanced cooling because heat losses are concentrated around the stator. Trickle impregnated (not applicable for 3069) in resin (Class H insulation), the stator windings are rated at 180°C (355°F) and enable up to 30 starts per hour.

2. Cable entry
Water-resistant cable entry provides both sealing and strain relief functions to ensure a safe installation.

3. Sensors
Thermal sensors embedded in the stator windings prevent overheating. Optional leakage sensors in the stator and oil housings are also available.

4. Long-life bearings
Durable bearings provide a minimum service life of 50,000 hours.

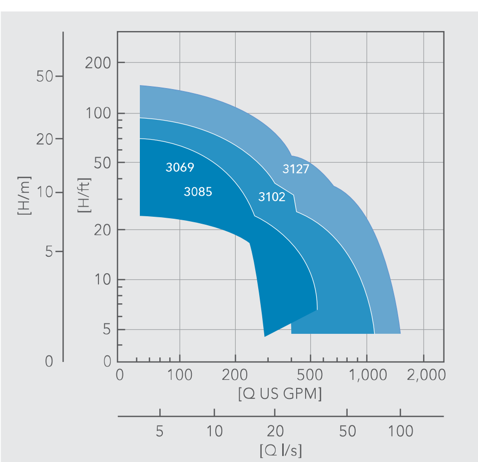
5. Enduring seals
The Griploc™ system consists of two sets of mechanical shaft seals that operate independently to provide double security against leakage.

Compliance
Each pump is tested and approved in accordance with national and international standards, including 60034-1 and CSA. Pumps are available in explosion-proof versions for use in hazardous environments, and are approved by the Factory Mutual, European Standard and IEC.

Power ratings and size

Model	3069	3085	3102	3127
Rating, hp	2-3.8	2.2-4	5-6	7.5-11
Discharge, in	2″ (50 mm)	3" (80 mm)	3" (80 mm)	3" (80 mm)
	2.5″ (65 mm)		4" (100 mm)	4" (100 mm)
	3″ (80 mm)		6" (150 mm)	6" (150 mm)

Performance, 60 Hz



Adaptive N-impeller solves clogging issues for small-range wastewater pumps

Clogging is the most common problem in wastewater pumping and a particular issue for small pumps due to their limited hydraulic space. The consequences include increased energy consumption, additional maintenance and emergency call-outs, all of which result in higher operating costs. Wastewater pump manufacturers are continually striving to develop improved hydraulics that reduce clogging while maintaining high performance.

Adaptive N-impeller pumps can be installed in screened and unscreened sewage stations, pumping wastewater from households, commercial buildings, hospitals, schools, etc. They can also be used in industrial effluent and stormwater run-offs that may carry solids, fibers and other types of waste.

The design enables a marked improvement in pumping system stability, with reduced costs for energy consumption and unplanned maintenance.

Historical perspective

Since the early 20th century, pump designers have focused on throughlet size in order to reduce clogging. The main pumping applications were mining, industry and raw water, not wastewater. Hard, solid and spherical objects in the pumped media were the most common clogging issues and large impeller throughlets enabled these objects to pass more easily through the pump.

Traditional impellers
Wastewater pumps have also been traditionally designed with large throughlets to avoid clogging. However, this design has proved to be non-optima for most wastewater applications. The two main traditional designs are the channel impeller and the vortex impeller.

Figure 1: Single-channel impeller

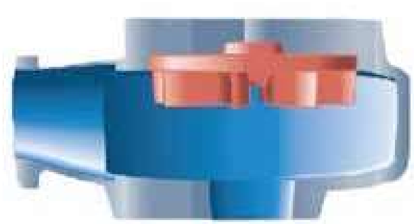


Figure 2: Vortex impeller

Figure 1 shows a single-channel impeller. Channel impellers can also have two or three channels. This closed centrifugal impeller has a large throughlet and is efficient when pumping clean water. However, the design is prone to clogging when pumping wastewater.

Figure 2 shows a vortex impeller that is recessed from the pump housing. This design has a large throughlet but low efficiency both with clean water and sewage. Pump designers assumed that the high-speed impeller would create a strong vortex inside the volute that would pump out the liquid sucking in all debris. Since the impeller is positioned out of the liquid flow path, it was also assumed that objects would never be in contact with the impeller and the pump would not clog. But in reality, the vortex impeller has proven to be sensitive to clogging.

Current perspective

Today's wastewater
Historically, the focus has been on large and hard objects in wastewater, while the risks related to soft and stringy matter have been neglected. Over time, the composition of wastewater has changed. Today's wastewater contains a significantly higher proportion of soft objects, and this trend is continually increasing.

Detailed investigations and studies of modern wastewater have shown that it almost never contains hard and spherical objects with a diameter as large as the inner diameter of the piping system. Even if such objects enter the wastewater system, they are usually deposited or trapped in areas where the carrying velocity is low, and they will not reach the pumps.

The most common solids found in municipal wastewater are elongated and stringy objects. The ever-increasing array of household and personal hygiene products, including tissues, wipes, rags, dishcloths and other fibrous objects, is a major problem. While a large proportion of these products should be disposed of in the trash, many consumers flush them down the toilet. Thus, more unbreakable fibers show up in wastewater and further challenge the pumps.

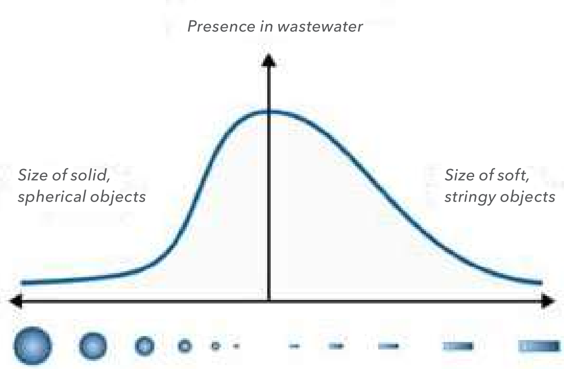


Figure 3: Solids distribution in wastewater

Figure 3 is a conceptual representation of the probability of finding different types of solids in wastewater. Hard and approximately spherical objects are to the left, while soft and elongated objects are to the right. As in many systems, the probability of finding extremely large objects, either spherical or elongated, is very low. The important characteristic is that this distribution curve is asymmetrical – there is a bias towards soft, elongated objects, which are the most common in today's wastewater.

Soft- and hard-clogging
It has been demonstrated that clogging issues are mainly caused by stringy objects, which tend to get caught on the leading edge of traditional impellers. The fibers wrap around the leading edges of the impeller and fold over on both sides of the vane. On straight and moderately curved leading edges, the debris will not dislodge – instead, it will continue to build up. These accumulations create large lumps or bundles of solid material that lead to clogging.

As objects gradually accumulate around the impeller's leading edges, the free passage of liquid is reduced and pump performance decreases. This phenomenon is called soft-clogging because it does not cause the pump to stop. The pump will continue to operate, but performance will be reduced to a certain degree. A typical effect of soft-clogging is that the pump will have to operate for a longer time to pump out a given volume of wastewater. The efficiency of a soft-clogged pump is also lower than that of a non-clogged pump. Other consequences of soft-clogging are increased energy consumption and higher vibration levels, which leads to accelerated wear of seals and bearings.

In addition to soft clogging of the impeller vanes, thin foreign objects can get stuck between the volute and the impeller, causing additional friction. The motor needs to supply even greater torque to counteract the braking effect, so higher input power is required. Once the running current exceeds the trip current, the pump will stop. This is called hard-clogging. Hard-clogging can also occur when soft-clogging creates significant rag balls. The main effect of hard-clogging is the need for an unplanned service call to unclog and restart the pump.

Traditional impellers

The last few decades of research and development, combined with experience from hundreds of thousands of pump installations, have shown that the simplistic logic of throughlet size to be incorrect and misleading. But it is still prevalent in wastewater pump procurement specifications. User feedback and laboratory tests with traditional impellers have yielded the results below.

Channel hydraulics
Channel hydraulics are designed to reach the best clog-resistance at the Best Efficiency Point (BEP) of the pump. Therefore the further the duty point is from the BEP, the lower the clog-resistance will be. Gradual build-up of fibrous material over the leading edge. (Figure 4) will cause efficiency to drop significantly below

the clean water value – a typical effect of soft-clogging. This long-used design also suffers from significant rotating radial forces, which cause heavy stress on shaft and bearings, increasing vibration and noise. In addition, since the impeller is never perfectly balanced, vibration is further increased.

These issues ultimately result in increased energy consumption, excessive wear and a shortened pump lifespan.

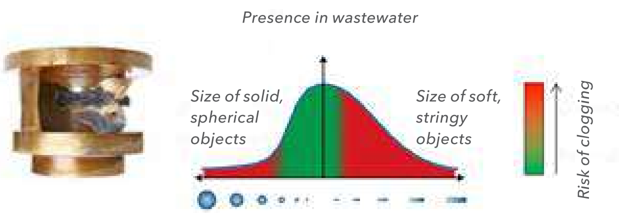


Figure 4: Clogging in channel impellers

Vortex hydraulics
Vortex pumps are unlikely to hard-clog due to the open impeller design and spacious volute. But the clog-resistance is based on the false assumption that the impeller is out of the flow path. It is assumed to work like a torque converter, where energy is transmitted from impeller to pumped media with no or little flow exchange. However, the vortex impeller functions like any other centrifugal pump, which means energy is transmitted to the media throughout the impeller vanes. The multi-vane vortex impeller is thus very sensitive to soft-clogging at the hub and the leading edge. The flow pattern and pressure distribution cause the soft materials to cover the impeller vanes, significantly reducing the already low hydraulic efficiency.

Additionally, that vortex pumps tend to accumulate a lot of solids in the volute, causing additional losses and increasing power consumption.

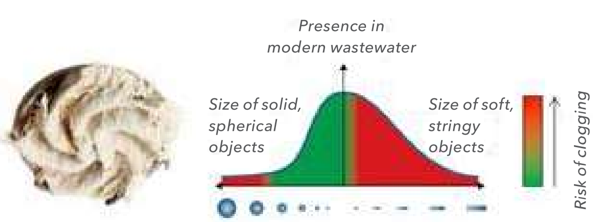


Figure 5: Clogging in Vortex impellers

For further details, see the White Paper:
"Wastewater pump clog resistance cannot be determined by throughlet size"

Modern design: Self-cleaning N-impeller
Studies and investigations have shown that clogging issues are mainly related to the difficulty for pumps to expel stringy objects caught around the leading edges of the impeller. The N-impeller, featuring a state-of-the-art self-cleaning design, has been developed in response to these findings. With substantially back-swept leading edges and a relief groove, the N-hydraulic design has proven to be the solution to most clogging problems. Furthermore, without the need for a large throughlet, impellers can be designed with multiple vanes, which helps to reduce radial forces, improve balance and increase efficiency.

Figure 6 shows a cutaway view of the N-hydraulic design, which includes a semi-open N-impeller and an insert ring with a guide pin. Figure 7 shows the clogging probability of the N-impeller, which is much lower than that of a traditional impeller.

Figure 6: Self-cleaning pump – Hydraulic part

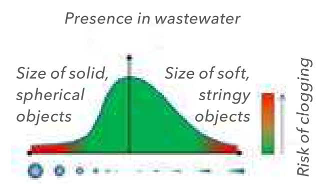


Figure 7: Clogging in self-cleaning N-impellers

This self-cleaning technology works as follows:
1. The N-impeller blades with back-swept leading edges enable self-cleaning by sweeping solids from the center to the perimeter of the insert ring.
2. The relief groove located in the insert ring acts together with the leading edge to guide solids out of the impeller.
3. At small-scale geometries, a specially designed guide pin catches the fibers stuck close to the impeller hub and allows the blades to push them out of the pump along the relief groove. The risk of blockage at the hub of semi-open impellers thus becomes negligible.

Thanks to the ability to expel tough objects, the self-cleaning technology considerably reduces unplanned maintenance and increases reliability. By avoiding stringy objects wrapping around the leading edges and causing soft clogging, the N-impeller ensures sustained high efficiency over time and thus lower energy consumption.

For further details, see the White Paper:
"Understanding Sustained Efficiency in Non-Clog Pumps"

Unlike channel hydraulics, the clogging resistance of the self-cleaning N-hydraulics is based on a mechanical principle and unaffected by flow variations. The pump can therefore run efficiently at different duty points on the performance curve and, above all, at several frequencies with high reliability. A combination with VFD can result in better process control, energy savings, smoother operation and reduced maintenance costs.

For further details, see the White Paper: "Variable speed wastewater pumping"

Self-cleaning N-hydraulics development

Limited torque of small N-pump

A submersible pump is typically driven by an electric motor that is close-coupled with the pump impeller, as shown in Figure 8. When a pump starts, electrical current passes into the winding of the stator and creates a rotating magnetic field, which results in spinning the rotor via a shaft. Consequently, the motor generates torque that is proportional to the motor power. Torque is a physical quantity that defines the tendency of a force to rotate an object around an axis or a point.

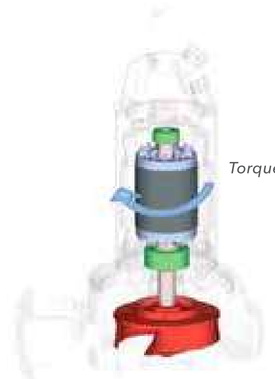


Figure 8: Representation of torque

As discussed earlier, objects passing through a self-cleaning N-pump are pushed out along the relief groove. Since the clearance between the impeller blades and insert ring is very small, just tenths of millimeters, large debris has to pass through the relief groove. When this happens, extra friction is created that acts as a brake on the impeller and tends to decelerate it. The pump must provide extra torque to overcome this extra friction, which means higher motor torque is required. If the maximum motor torque is insufficient, the debris will get stuck and stop the pump. This is hard-clogging.

As submersible motors are usually not greatly oversized, the maximal torque supplied at full power might not be sufficient to push the toughest debris away. This is particularly true for smaller pumps, for which the torque margin becomes comparatively small. In order to further improve the functionality of the N-pumps, Adaptive N-technology was developed to reduce the risk of hard-clogging due to insufficient torque.

Adaptive N-technology

With the adaptive technology, the N-impeller is not totally fixed on the shaft: it can move axially up and down. This movement makes it possible to increase the clearance between the impeller blades and the insert ring, enlarging the relief groove. Therefore the most bulky rags and the toughest of debris can pass smoothly through the pump, without the need for extra motor torque. The benefits are even greater when pump motors are operated on single-phase power sources where available torque is further reduced.

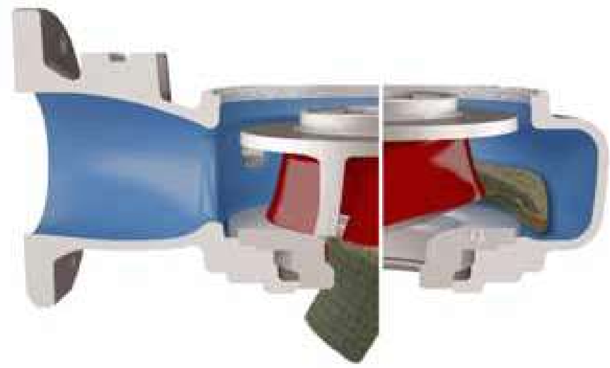


Figure 9: Impeller positions during operation

As shown on the left side of Figure 9, most of the time the Adaptive N-impeller works exactly the same way as a regular N-impeller. But when needed, the impeller moves up axially to pass larger debris as shown on the right side of Figure 9. Since this adaptive motion only lasts a fraction of a second, the momentary power increase has no significant effect on overall pump efficiency.

In addition, this adaptive function reduces loads on the shaft, seals and bearings and thus increases their lifetime.

In conclusion, with Adaptive N-technology, the self-cleaning functionality for small pumps with low torque motors is significantly improved. Ultimately, reliable operation and sustained high efficiency lower the total cost of ownership.

How it works

The adaptive function allows the impeller to travel axially, temporarily increasing the clearance between impeller and insert ring so that large debris can pass through.

The adaptive mechanism works with hydraulic pressure differences over the impeller. The force related to the pressure is F=PxA, where P is pressure and A is the area where the pressure is applied. Figures 10 and 11 show how the combined forces determine the impeller position.

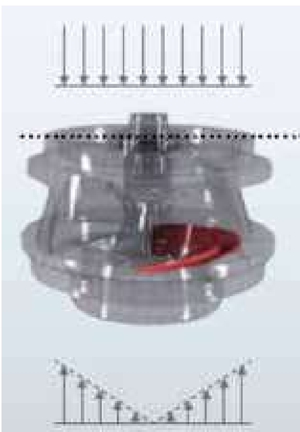


Figure 10: Force distribution during normal operation

Figure 11: Force distribution when debris enters the pump

Figure 10 shows a conceptual image of the hydraulic forces distributed on the impeller in light contaminant wastewater. At the bottom of the impeller, the upward pressure increases over the radius so the force grows from the center to the edge of the impeller. Meanwhile, at the top of the impeller, a higher pressure acts uniformly on the entire impeller disc. The combined force on the impeller has a net downward value and retains the impeller in the normal operating position.

However, when a large piece of debris enters the impeller and tends to clog the pump, the force balance will differ from normal operation. As shown in Figure 11, a gradually increasing upward force is added to the hydraulic forces at the impeller bottom. When the resulting upward force exceeds the downward force, the impeller starts moving up and the clearance between the impeller and insert ring becomes larger. When the clearance is large enough, the debris will pass the impeller. Then the upward force decreases and the impeller returns to its original operating position.

Note: Although a spring is inserted above the impeller, it is not connected to the adaptive functionality. The spring keeps the impeller locked during transport, avoiding potential damage before setup.

Adaptive N availability

As explained earlier, N-technology features a mechanical self-cleaning function that requires a certain amount of torque to work properly. The maximum available torque for the small pumps might not be enough to expel the toughest debris from the pump and prevent hard-clogging. Adaptive N-impellers have therefore superseded standard N-impellers for the small range.

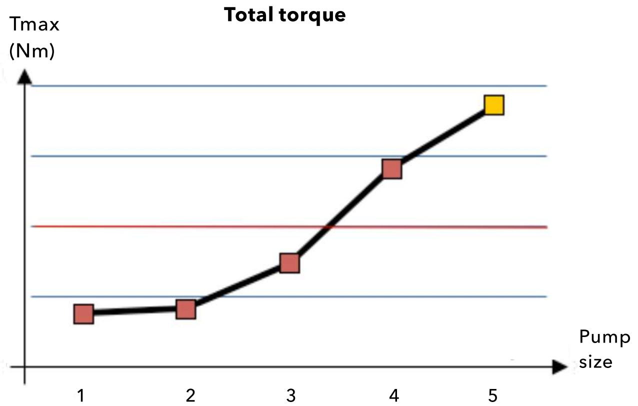


Figure 12: Total torque graph

Figure 12 is a conceptual diagram showing the maximum available torque for the five smallest N-pumps of the range, where the pump 1 has the smallest capacity and the red line is the required torque to prevent typical hard-clogging. It appears that pumps 1, 2 and 3 do not have enough torque to overcome the typical hard-clogging, whereas pumps 4 and 5 do.

However, it has been decided to include pump 4 in the list of the pumps equipped with Adaptive N-technology to ensure reliability.

In conclusion, pumps 1, 2, 3 and 4 are equipped with Adaptive N-hydraulics to handle hard-clogging, while pumps 5 and above have standard N-impellers since the torque is already sufficient.

Life Cycle Cost analysis for small wastewater pumps

Life Cycle Cost (LCC) analysis is a methodology used to determine the total cost of a system over its lifetime, or to compare different investment plans. A complete LCC analysis of any piece of equipment includes all costs related to that equipment, including initial investment, installation, operation, energy, downtime, environmental, maintenance and disposal. The parts of the equation that matter the most will depend on application, geographic location, labor costs and energy cost – factors that can vary significantly between markets.

When evaluating alternative wastewater pump options, a simplified analysis is often used. In this case, the most relevant factors are initial investment, energy cost and maintenance cost (especially unplanned maintenance). Other factors can be excluded from the analysis.

Clogging is the most significant factor in unplanned maintenance costs. The number of times a pump clogs in a pump station can vary greatly. The most common factors are:

- Type of pumped media
- Type of pump hydraulics
- Length of pump operating cycles
- Size of pump
- Motor torque and moment of inertia

Increased energy cost due to soft-clogging

As stated above, a channel-impeller pump in a wastewater application might suffer from soft-clogging and may trip after a long cycle operation. A vortex-impeller pump suffering from soft-clogging, however, might continue running due to the large space in the pump housing. This larger space allows for more solid accumulation than other types of pumps. In either case, soft-clogging tends to reduce pump efficiency and induce hard-clogging.

Figure 13 shows the impact of soft-clogging on efficiency and energy consumption for traditional pumps (channel or vortex hydraulics), and self-cleaning pumps (N- or Adaptive N-hydraulics) over time. As shown in Figure 13a, when a traditional pump runs continuously in wastewater, efficiency decreases and energy consumption gradually increases. The trend is the same when a traditional pump runs intermittently (Figure 13b), even if back-flushing achieves temporary efficiency gains as well as spikes in energy consumption. However, Figure 13c shows that a self-cleaning pump maintains consistent efficiency and energy consumption during continuous or intermittent operation in wastewater. Consequently, self-cleaning N- and Adaptive N-pumps have the lowest energy consumption over time.

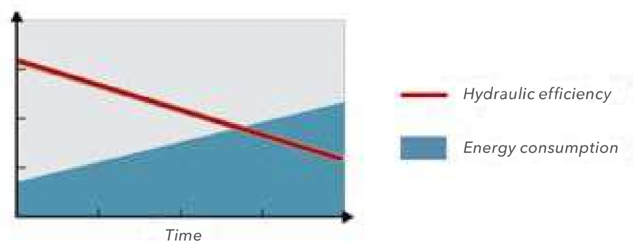


Figure 13a: Traditional pump running continuously

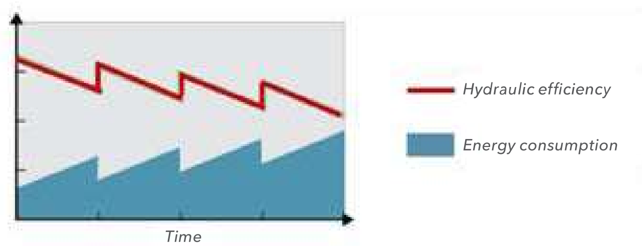


Figure 13b: Traditional pump running intermittently

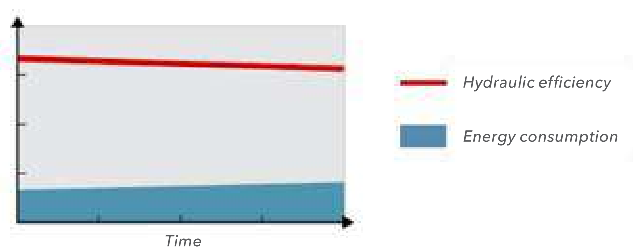


Figure 13c: Self-cleaning pump running continuously and intermittently

Increased energy costs due to soft-clogging can be easily measured on site. However, predicting these extra costs is difficult due to the variability of the media properties and the operation cycles.

Simplified LCC comparison example

The example below demonstrates the simplified LCC analysis between three different pump types based on two operation times: 3 hours/day and 12 hours/day.

Pump media		Unscreened raw sewage		
Flow		25 l/s		
Head		8 m		
Running years		5 years		
Energy cost		0.1 euro/kWh		
Unplanned maint. cost		200 euro/call-out		
Pump selection		**Channel impeller**	**Vortex impeller**	**Adaptive N-impeller**
Rated power (kW)		3.1	4.7	3.1
Hydraulic efficiency (clean water)		75%	46%	77%
Total efficiency (clean water)		63%	38%	65%
Specific energy (kWh/m³)		0.0346	0.0574	0.0335
No. of call-outs/year	**Operation 3 hours/day**	4	2	0.5
	Operation 12 hours/day	16	8	2

LCC analysis is a useful method to determine an appropriate pump selection. The conclusions from the above example are:

- The initial investment of various hydraulic pumps does not make a big difference. In a long operation cycle, the initial investment is only a small proportion of LCC, while the unplanned maintenance cost caused by hard-clogging makes a greater contribution to LCC.
- In figure 14, when the channel-impeller pump runs 12 hours/day over 5 years, the unplanned maintenance cost is more than 5 times the initial investment. Comparatively, the maintenance cost of the Adaptive N-impeller pump is only 60% of its initial investment. Adaptive N-technology can significantly reduce maintenance costs.
- The vortex impeller pump appears to have fewer call-outs than the channel impeller pump, but the nominal energy cost for vortex impeller pumps in clean water is always higher than for other pumps. In addition, since the extra energy cost caused by soft-clogging is difficult to predict, it is not counted in an LCC calculation and thus not shown in the diagram. Considering this, a vortex hydraulic pump will have higher energy consumption compared to the other two hydraulics.
- In figures 14 and 15, the Adaptive N-impeller pump has the lowest LCC in clean water. If the extra energy consumption due to soft-clogging is taken into account, the Adaptive N-pump can save even more than the LCC analysis indicates. In addition to the economic gains, the N-pump offers peace of mind to end users.

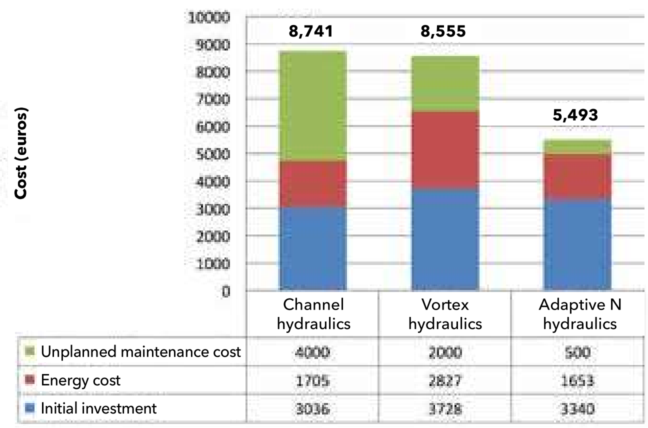


Figure 14: Simplified LCC analysis based on operation time 3 hours/day

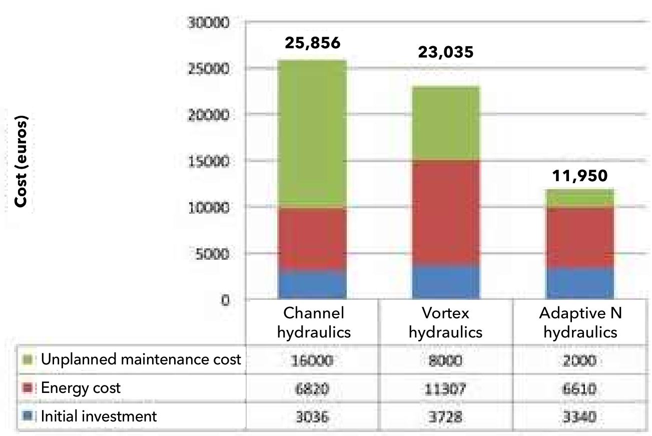


Figure 15: Simplified LCC analysis based on operation time 12 hours/day

For further details, see the White Paper: "Life Cycle Costs (LCC) for wastewater pumping system"

Summary

The ever-increasing focus on minimizing operating costs creates a demand for pumps with better clog-resistance and higher efficiency, especially in wastewater applications. Twenty years ago, a self-cleaning hydraulic design was developed for this purpose. Equipped with back-swept leading edge and relief groove, the semi-open N-impeller can considerably reduce the risk of clogging. Consequently, N-pumps provide sustained high efficiency and higher reliability than any traditional hydraulic design. Self-cleaning N-pumps have therefore been well-received all over the world.

Due to the limited size and motor torque in small wastewater pumps, the use of N-technology has been challenged in the toughest applications. In order to further enhance the self-cleaning function, especially to reduce the risk of hard-clogging in pumps with relatively low torque, the N-impeller has been complemented with adaptive technology. Adaptive N-hydraulics is a new way of connecting the impeller to the shaft, allowing the impeller to move axially, so the toughest debris can pass through. The results from numerous lab and field tests show that Adaptive N-hydraulics can effectively solve both soft- and hard-clogging issues for small pumps.

Additionally, LCC analysis shows huge potential savings for Adaptive N-pumps. In most cases, the savings are derived from lower energy consumption and reduced unplanned maintenance costs.

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