



ADSORPTION · REGENERABLE PHOSPHATE ADSORBER

PhosSorb-HC

High Capacity Phosphate Adsorber

IRON HYDROXIDE COATED MSF

PHOSPHATE REMOVAL / WATER PROTECTION / NUTRIENT RECOVERY

900 kg/m³

Nominal bulk density

20 BV/h

Design service rate

3 min

Empty-bed contact time at
design rate

2% KOH

Regeneration chemical

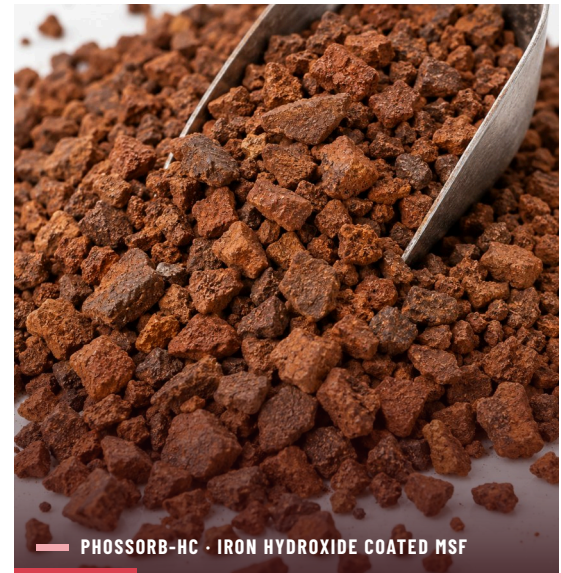
01 / PRODUCT PROFILE

IRON HYDROXIDE COATED MSF

PhosSorb-HC - High Capacity Phosphate Adsorber

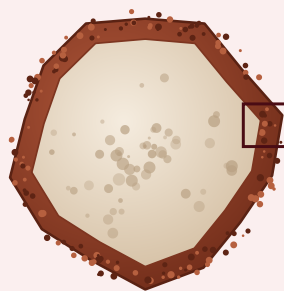
PhosSorb-HC combines an iron hydroxide coating with a granular mineral support for fixed-bed phosphate adsorption. MSF means Metallic Silicate Framework, Watch Water's technology designation. The medium is designed for regeneration and repeated service.

PROPERTY	PRODUCT INFORMATION
Physical form	Coated mineral granules
Target substance	Phosphate
Nominal bulk density	900 g/L = 0.90 kg/L = 900 kg/m ³
Design service rate	20 bed volumes per hour (20 BV/h)
Contact time at design rate	3 minutes empty-bed contact time
Regeneration chemical	Potassium hydroxide (KOH), 2% solution
Process format	Media-retaining vessel or adsorption filter



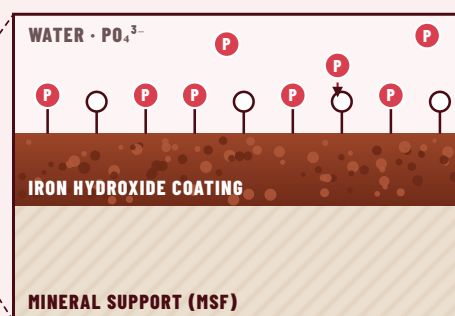
PHOSSORB-HC · IRON HYDROXIDE COATED MSF

01 GRANULE CROSS-SECTION



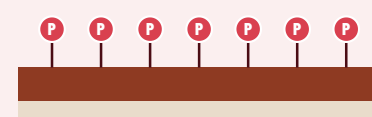
○ Surface site ≡Fe-OH ● Phosphate

02 SURFACE, MAGNIFIED

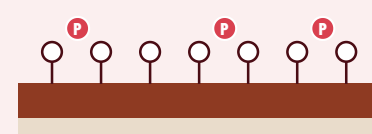


03 CYCLE STATE

SERVICE · PHOSPHATE BOUND



REGENERATED · 2% KOH



SURFACE CHEMISTRY IN A REUSABLE BED

Iron (hydr)oxide surfaces can bind phosphate, and alkaline desorption has been investigated as a route to recovery and reuse. Accessible surface sites, solution chemistry and contact time influence performance. Published research on iron (hydr)oxide media supports the approach; project sizing uses the working capacity measured for PhosSorb-HC in the intended water. ^{11,12}

SERVICE · ADSORPTION



Phosphate exchanges with surface hydroxyl groups.

REGENERATION · 2% KOH



Hydroxide releases phosphate into the regenerant.

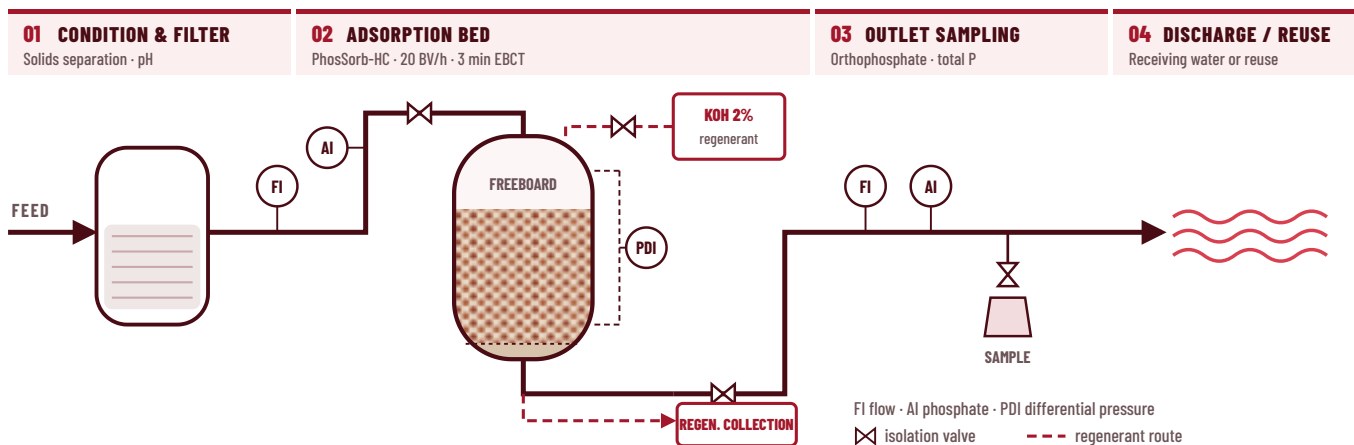
Hydraulic values are design inputs; loading and outlet targets are set for each application.

SOURCES 11 Kunaschk et al. (2015), Water Research 71 · 12 Huang et al. (2026), Water Research 307

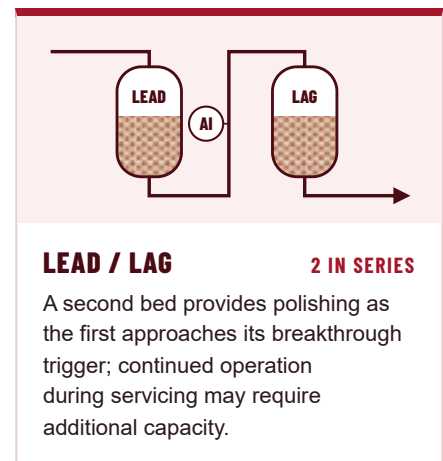
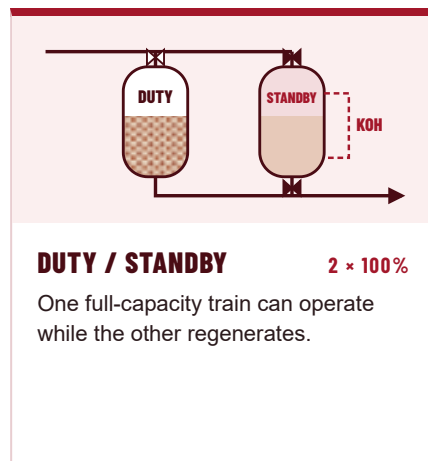
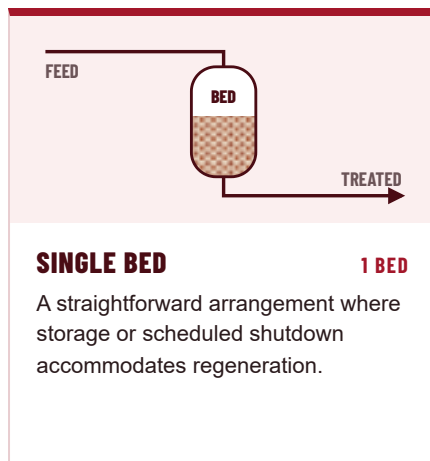
02 / SYSTEM INTEGRATION

A CONTROLLED BED. A MEASURABLE RESULT.

Build phosphate capture into a treatment train with sampling, isolation and a clear regeneration route.

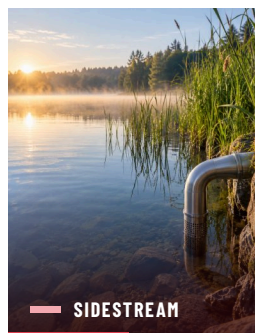


CHOOSE A LAYOUT THAT FITS CONTINUITY NEEDS



MEASURE THE TREATMENT, NOT ONLY THE FLOW

Provide inlet and outlet sampling, flow measurement, pressure-drop monitoring and appropriate media-retention screens. Trend dissolved orthophosphate alongside total phosphorus where required. Set regeneration triggers from the outlet target and validated breakthrough behaviour.



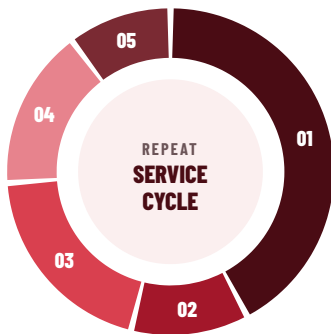
SURFACE-WATER APPLICATIONS

For ponds, lakes and reservoirs, assess managed sidestream treatment or interception of incoming phosphate-bearing flows. Hydraulic reach, catchment inputs and sediment release determine how much of the overall phosphorus budget the installation can address.

03 / REGENERATION

REGENERABLE. BUILT INTO THE CONCEPT.

Adsorb. Isolate. Regenerate. Rinse. Return to service.



Regeneration transfers captured phosphate from the medium into a separate liquid stream and prepares the bed for another service cycle. PhosSorb-HC uses a potassium hydroxide regeneration approach, linking phosphate capture with a potential nutrient-recovery route.

01 ADSORB	Service at 20 BV/h
02 ISOLATE	Bed taken off-line
03 REGENERATE	2% KOH draw and contact
04 RINSE	To pH and quality endpoints
05 RETURN	Bed back in service

NOMINAL REGENERATION SEQUENCE - 120 MINUTES

REGENERANT DRAW	45 MIN	CONTACT	30 MIN	CLEAN-WATER RINSE	45 MIN
NOMINAL STAGE	TIME	OPERATING PURPOSE			
Regenerant draw	45 min	Introduce the specified 2% KOH solution.			
Contact	30 min	Maintain the prescribed regeneration contact.			
Clean-water rinse	45 min	Rinse to the specified outlet pH and water-quality endpoints.			

The nominal sequence totals 120 minutes. Actual return-to-service time includes isolation, preparation and confirmation of the required outlet conditions. Regenerant volume, concentration basis, flow and dosing instructions are set in the project operating procedure.



BACKED BY REGENERATION RESEARCH

Kunaschk et al. studied regeneration of granular ferric media and showed that surface deposits and solution chemistry affect capacity recovery. An adapted procedure maintained performance through repeated cycles for selected media. A 2026 study by Huang et al. identifies post-regeneration neutralisation as a way to improve stability in calcium- and natural-organic-matter-rich waters. ^{11,12}

Watch Water develops the regeneration procedure for PhosSorb-HC and the actual feed water.

SOURCES 11 Kunaschk et al. (2015), Water Research 71 · 12 Huang et al. (2026), Water Research 307

04 / NUTRIENT RECOVERY

KEEP PHOSPHORUS IN PRODUCTIVE USE.

Recovered phosphorus. Potassium from regeneration. A route to magnesium-enriched fertiliser.

PhosSorb-HC captures phosphate in a regenerable bed. Collect the phosphate-rich KOH regeneration stream separately and prepare it for an appropriate nutrient-reuse route. Phosphorus comes from the treated water; potassium comes from the regenerant.

P

PHOSPHORUS

Captured from the treated water

K

POTASSIUM

Supplied by the KOH regenerant

Mg

MAGNESIUM

Optional MgO-assisted recovery route

P + K: PLAN A USEFUL AGRICULTURAL NUTRIENT STREAM

Condition and analyse recovered batches before blending for irrigation or fertigation. Match phosphorus and potassium application to soil tests, crop demand and seasonal uptake. Regular regeneration supplies manageable batches; storage separates treatment operations from the timing of crop nutrition. ¹³



MAGNESIUM: AN ADDITIONAL NUTRIENT-RECOVERY ROUTE

Magnesium is part of chlorophyll and supports plant enzyme activity. Correcting a magnesium shortage can support healthy crop growth. A magnesium-enriched recovery product can therefore be evaluated where soil and crop requirements justify supplementation. ¹⁷

Published studies show that MgO can supply magnesium and alkalinity for phosphorus recovery by precipitation, including struvite where ammonium is available. This supports evaluating MgO in a separate recovery tank after desorption. KOH remains the regenerant for PhosSorb-HC. ¹⁶

01 COLLECT AND ANALYSE

Measure P, K, pH, salinity and source-relevant contaminants.

02 CONDITION OR RECOVER SOLIDS

Select a liquid nutrient route or assess magnesium-assisted precipitation.

03 MATCH TO AGRICULTURE

Set application rate, dilution and timing from crop and soil needs.

KOH is the specified regenerant for PhosSorb-HC; MgO-assisted recovery is available as a development option. Agricultural reuse is assessed for pH, salinity, contaminants and applicable reuse requirements.

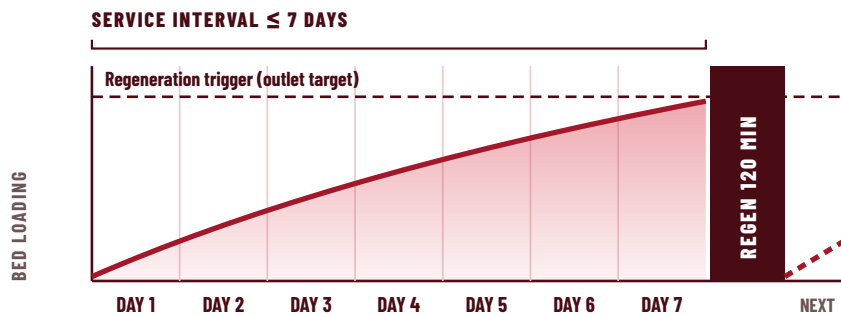
SOURCES ¹³ Ayers and Westcot (1985), FAO Irrigation and Drainage Paper 29 ¹⁶ MgO struvite-recovery studies (2020, 2023) ¹⁷ University of Minnesota Extension, Magnesium for crop production

05 / COMPACT WEEKLY OPERATION

SIZE FOR A WEEK. REGENERATE FOR REPEAT USE.

A short service cycle can reduce capacity-driven media inventory and deliver regular nutrient-recovery batches.

Design PhosSorb-HC installations for a service interval of no more than seven days, with earlier regeneration when the outlet trigger is reached. This approach sizes the adsorption inventory for a repeatable operating cycle instead of storing a full year of captured phosphorus in the bed.



Bed loading across one service interval, followed by regeneration.

TWO REQUIREMENTS DETERMINE THE MEDIA VOLUME

HYDRAULIC VOLUME (L)

$$= \text{peak flow (m}^3/\text{h)} \times 1,000 \div \text{service rate (BV/h)}$$

CAPACITY VOLUME (L)

$$= \text{P load removed per cycle (g)} \div \text{working capacity (g P/L media)}$$

Use the larger volume, then include the operating reserve and availability requirements.

SEVEN-DAY DESIGN EXAMPLE

DESIGN INPUT OR RESULT	VALUE
Flow and operating schedule	10 m ³ /h, 24 hours/day
Phosphorus concentration reduction	1.0 mg P/L
Daily / seven-day P removal	0.24 kg/day / 1.68 kg per cycle
Hydraulic volume at 20 BV/h	500 L of media; approximately 450 kg
Capacity needed for that 500 L bed	3.36 g P/L per cycle, before reserve

If the measured working capacity is below 3.36 g P/L, increase the bed volume or regenerate more frequently. Hydraulic demand can set the minimum bed size, so vessel dimensions are confirmed for each project.

Weekly collection supports planned nutrient recovery. Store and condition recovered batches so application follows crop demand and the growing season.

Final bed volume is confirmed from the working capacity measured in the project water. A duty/standby arrangement maintains treatment during regeneration; both beds are included in the installed footprint.

06 / THE ENVIRONMENTAL CASE

ACT BEFORE NUTRIENTS BECOME BLOOMS.

Phosphate control is an investment in the waters that communities, industries and ecosystems share.

EXCESS N AND P

ALGAE AND CYANOBACTERIA

REDUCED WATER CLARITY

OXYGEN CONSUMED

WHY EUTROPHICATION MATTERS

Excess nitrogen and phosphorus can accelerate the growth of algae and cyanobacteria. Dense growth reduces water clarity; the breakdown of accumulated biomass consumes oxygen. The result can include degraded aquatic habitat, odour, lost recreational use and greater demands on water treatment.^{1,2}

CYANOBACTERIA DESERVE PARTICULAR ATTENTION

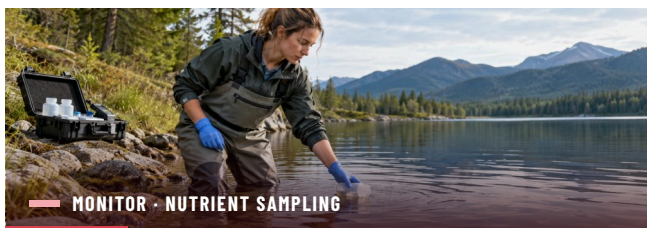
Cyanobacteria are photosynthetic bacteria, often called blue-green algae. Some species can produce cyanotoxins. Bloom appearance alone cannot establish whether toxins are present, and phosphate treatment is distinct from toxin removal or disinfection. Reducing nutrient inputs addresses one of the conditions that supports excessive growth.^{2,3}

A WATERSHED NEEDS A NUTRIENT STRATEGY

Phosphorus control is central to many freshwater restoration programmes. Across rivers, estuaries and coastal waters, nitrogen can also be limiting or jointly limiting. Effective management follows the receiving water: nutrient sources, seasonal loads, residence time, temperature and ecological response all matter.^{3,4}

THE ROLE FOR PHOSSORB-HC

Capture dissolved phosphate from identified treatment streams as part of a wider programme to reduce nutrient loading.



MONITOR · NUTRIENT SAMPLING



PROTECT · CLEAR, HEALTHY WATER

The environmental benefit grows with the share of the total nutrient load treated, alongside continuing watershed inputs and the response of the receiving water.

SOURCES 1 US EPA, Basic Information on Nutrient Pollution 2 US EPA, Harmful Algae, Cyanobacteria and Cyanotoxins 3 US EPA, What Causes HABs 4 Paerl (2009), Estuaries and Coasts 32

07 / EVIDENCE FROM REAL WATERS

THREE STUDIES. ONE PRACTICAL DIRECTION.

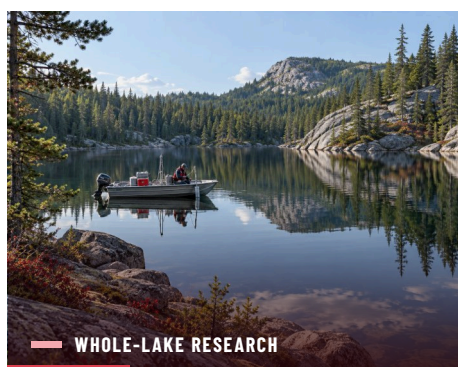
Identify the nutrient pressure, control the load and monitor the ecological response.



LAKE WASHINGTON, USA

SOURCE CONTROL AND RECOVERY

King County documents how sewage-derived phosphorus encouraged nuisance growth in Lake Washington. Wastewater diversion reduced phosphorus inputs, followed by major improvements in lake conditions. The previously prominent cyanobacterium *Oscillatoria* disappeared from the record described by the county in 1976. The lesson is the value of reducing external phosphorus loading.⁵



LAKE 227, CANADA

A WHOLE-LAKE EXPERIMENT

Schindler and colleagues reported a 37-year experiment with continued phosphorus additions and progressively lower nitrogen additions. During the final 16 years, phosphorus alone was added. Nitrogen fixation helped sustain eutrophication, demonstrating that reducing nitrogen alone did not solve the problem in this lake. The experiment provides strong evidence for phosphorus control in this setting.⁶



LAKE ERIE, USA

THE COST OF A BLOOM

NOAA reported that an August 2014 cyanobacterial bloom left nearly 400,000 people in Ohio without drinking water for two days. NOAA also links western Lake Erie bloom severity to seasonal phosphorus loading. This case shows why nutrient reduction, bloom surveillance and drinking-water preparedness belong in the same management programme.^{7,8}

DESIGN IMPLICATION

Treat measurable phosphorus sources before discharge wherever site assessment shows a meaningful opportunity to reduce receiving-water loads.

SOURCES 5 King County, Lake Washington Story · 6 Schindler et al. (2008), PNAS 105 · 7 NOAA (2014), Lake Erie HAB response · 8 NOAA (2015), Lake Erie HAB forecasts

08 / FOLLOW THE PHOSPHORUS

FIND THE LOAD. CHOOSE THE TREATMENT POINT.

A useful nutrient audit follows both the water and the materials added to it.

SOURCE OR STREAM	WHAT TO INVESTIGATE
 MUNICIPAL WASTEWATER	Residual orthophosphate after secondary treatment; total phosphorus and seasonal flow.
 FOOD AND BEVERAGE PROCESSING	Product losses, process residues, cleaning chemistry and the quality of treated effluent.
 BOILERS AND COOLING SYSTEMS	Phosphate-containing treatment programmes, blowdown volumes and phosphorus speciation.
 RO AND WATER REUSE	Feed-water phosphorus, membrane recovery, concentrate quality and antiscalant chemistry.
 AGRICULTURE AND STORMWATER	Fertiliser and manure losses, erosion and collectable drainage or runoff pathways.
 LAKES, PONDS AND STREAMS	External inputs, circulation, water residence time and phosphorus released from sediments.

Agriculture, stormwater and wastewater are established sources of nutrient pollution. Their relative importance varies between catchments. Industrial treatment chemicals can add to a site inventory, but the presence and concentration of phosphorus must be established for each stream. ^{9,10}



Watch Water assesses each stream for phosphorus content and the most effective treatment point.

SOURCES 9 US EPA, Nutrient Pollution: Sources and Solutions · 10 US EPA (2004), Meat and Poultry Products Technical Development Document

09 / INDUSTRIAL APPLICATIONS

PROTECT THE PROCESS. TREAT THE DISCHARGE.

Separate the useful role of process chemistry from the need to manage residual nutrients.



STEAM BOILER HOUSE

BOILER BLOWDOWN

Phosphate programmes are used in some boilers to manage deposits and water chemistry. Blowdown from these systems can carry phosphorus in dissolved and particulate forms. A treatment assessment should include cooling or heat recovery, equalisation, pH conditioning and solids separation before a phosphate adsorption stage.



OPEN RECIRCULATING COOLING

COOLING-WATER BLOWDOWN

Some open recirculating cooling programmes use phosphate-containing corrosion inhibitors. Evaluate the actual programme and analyse the blowdown for orthophosphate and total phosphorus. Salts, hardness, other inhibitors, biocides and suspended material also belong in the treatment design.



FOOD AND BEVERAGE PRODUCTION

FOOD, BEVERAGE AND RELATED PRODUCTION

Phosphorus can originate from raw materials, product residues and cleaning agents. EPA documentation for meat and poultry processing identifies both organic and inorganic phosphorus sources. For PhosSorb-HC projects, evaluate clarified or biologically treated effluent as a polishing feed, with upstream removal of solids, fats and excessive organic load.¹⁰

BOILER BLOWDOWN - ASSESSMENT SEQUENCE



A TARGETED TREATMENT OPPORTUNITY

Place phosphate adsorption where the water is accessible, adequately pretreated and monitored - commonly after the main treatment process and before discharge or reuse.

Watch Water selects pretreatment and adsorption operating conditions from the actual stream analysis.

SOURCES 10 US EPA (2004), Meat and Poultry Products Technical Development Document

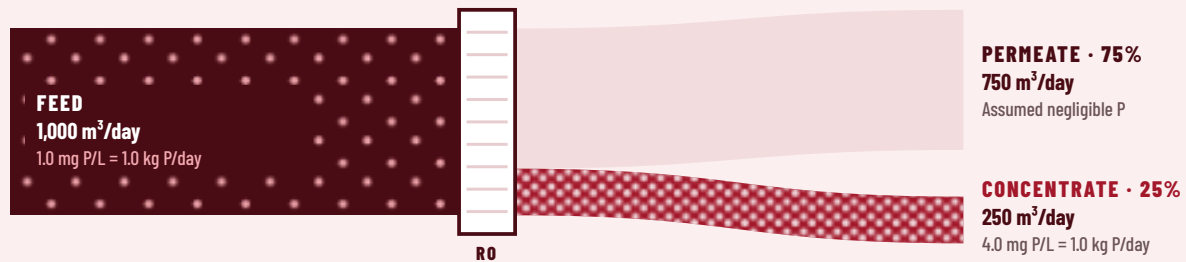
10 / REVERSE OSMOSIS CONCENTRATE

RO SEPARATES WATER. TRACK THE NUTRIENTS TOO.

A smaller reject stream can carry a substantial share of the feed-water phosphorus.

Reverse osmosis produces permeate and concentrate. Rejected solutes move into the concentrate stream; the membrane does not create phosphorus. Nutrient loading depends on the feed, chemical additions, rejection and discharge route. Phosphate-bearing concentrates merit assessment, especially where they reach nutrient-sensitive waters.

RO MASS BALANCE · DESIGN EXAMPLE



STREAM	FLOW	PHOSPHORUS
Feed	1,000 m ³ /day	1.0 mg P/L = 1.0 kg P/day
Permeate	750 m ³ /day	Assumed negligible P
Concentrate	250 m ³ /day	4.0 mg P/L = 1.0 kg P/day

At 75% water recovery, complete phosphorus rejection would produce a fourfold concentration. The daily phosphorus load remains 1.0 kg. The balance assumes no phosphorus additions, precipitation or accumulation within the system.

DESIGN AROUND THE COMPLETE CONCENTRATE CHEMISTRY

Measure orthophosphate, total phosphorus, pH, salinity, hardness and relevant treatment additives. Assess scaling and competing constituents during a representative column trial. Where other phosphorus forms are significant, evaluate their conversion or removal within the wider treatment train.

A FOCUSED ROLE FOR PHOSSORB-HC

Evaluate dissolved-phosphate polishing of suitable concentrates, supported by water-specific testing and a managed regeneration stream.

11 / ENGINEERING & ECONOMICS

MEASURE KILOGRAMS REMOVED. EVALUATE TOTAL COST.

The strongest business case connects nutrient load, working capacity and repeat use.

1.8 kg P/day 1,000 m³/day from 2.0 to 0.2 mg P/L	657 kg P/yr At 365 operating days	0.50 m³ Media for 10 m³/h at 20 BV/h	3 min Empty-bed contact time	≈450 kg Media at nominal bulk density
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Design example: 1,000 m³/day treated from 2.0 to 0.2 mg P/L, and a 10 m³/h stream at 20 BV/h.

START WITH THE DAILY PHOSPHORUS LOAD

$$\text{P removed (kg/day)} = \text{flow (m}^3\text{/day)} \times \text{concentration reduction (mg P/L)} \div 1,000$$

Use flow-weighted sampling when flows or concentrations vary.

Example: treating 1,000 m³/day from 2.0 to 0.2 mg P/L removes 1.8 kg P/day, or 657 kg P/year at 365 operating days.

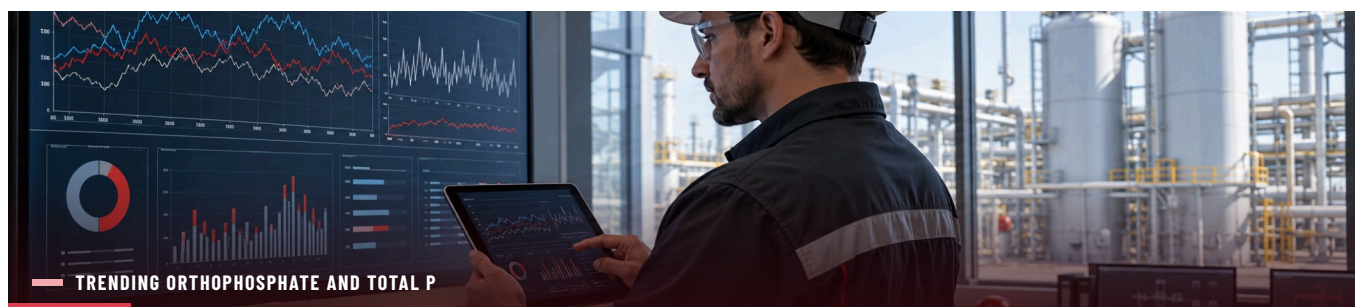
SEPARATE HYDRAULIC SIZING FROM ADSORPTION CAPACITY

At the 20 BV/h design rate, a 10 m³/h stream corresponds to 0.50 m³ of media and 3 minutes empty-bed contact time. At nominal bulk density, that media volume weighs approximately 450 kg. The service-cycle duration is set by the working capacity.

Cycle length comes from the working capacity achieved before the specified breakthrough limit. Determine it by column testing with the actual water and repeat the assessment after regeneration.

COMPARE ON A WHOLE-SYSTEM BASIS

INCLUDE IN COST	INCLUDE IN VALUE
Media, vessels and installation	Measured phosphorus removal
Regenerant, rinse water and conditioning	Verified nutrient-reuse credit
Pumping, labour, analysis and maintenance	Continuity supported by the selected layout
Residual handling and media replacement	Reduced replacement demand when repeat use is demonstrated



Cost per kg P removed and cost per m³ treated are compared over the same evaluation period. 1 mg P/L equals approximately 3.066 mg PO₄/L; PO₄-P denotes phosphorus mass.

12 / FROM WATER SAMPLE TO PROJECT

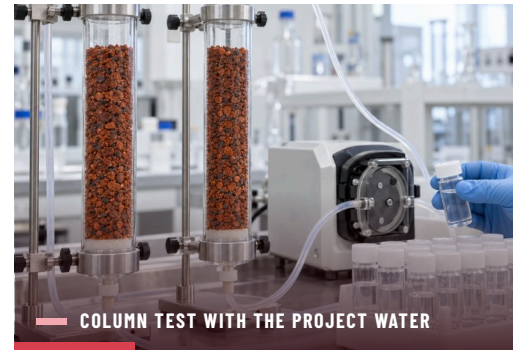
MAKE EVERY TARGETED INSTALLATION COUNT.

A clear specification turns an environmental objective into a treatment project.

DEFINE THE WATER AND THE OBJECTIVE

Supply average and peak flows; orthophosphate and total phosphorus results; pH, temperature, alkalinity, hardness and salinity; suspended solids and organic load; relevant process chemicals; and the required discharge or reuse quality. Include seasonal changes and the proposed destination of the regeneration stream.

- Average and peak flows
- Orthophosphate and total phosphorus
- pH, temperature, alkalinity, hardness, salinity
- Suspended solids and organic load
- Relevant process chemicals
- Required discharge or reuse quality



CONFIRM PERFORMANCE UNDER OPERATING CONDITIONS

A representative column programme establishes breakthrough, usable capacity, pressure drop, regeneration demand and capacity retention. Repeat-cycle observations support the service schedule and lifecycle cost estimate. Agree commissioning acceptance criteria before full-scale operation.

DRINKING-WATER SYSTEMS: RETAIN ESSENTIAL PROTECTION

Orthophosphate is used in some drinking-water networks to control lead and copper release. Preserve the required corrosion-control programme and assess phosphate capture at an appropriate downstream wastewater or discharge treatment point. ¹⁴

Legionella control requires a dedicated water-management programme addressing temperature, disinfectant residual, water age, sediment and biofilm. Phosphate removal is not a substitute for these controls, and phosphate dosing alone is not established as the cause of Legionella in water systems. ¹⁵

SOURCES 14 US EPA, Phosphate in drinking water · 15 CDC (2025), Controlling Legionella in Potable Water Systems

PROJECT PATH

01 WATER AND OBJECTIVE

Flows, phosphorus fractions, water chemistry and the discharge or reuse target.

02 COLUMN PROGRAMME

Breakthrough, usable capacity, pressure drop and regeneration demand.

03 ENGINEERING

Layout, bed volume, regeneration route and monitoring points.

04 COMMISSIONING

Acceptance criteria agreed before full-scale operation.

LET'S DESIGN THE PHOSPHATE-REMOVAL STAGE

Send us your water analysis and treatment objective.

INFO@WATCHWATER.DE

WWW.WATCHWATER.DE

Application selection, performance targets and nutrient-reuse arrangements are confirmed for each project.

13 / REFERENCES

EVIDENCE YOU CAN TRACE.

Superscript numbers in the text refer to the sources below, grouped by topic. Project performance, regeneration frequency and nutrient-reuse benefits are confirmed for the actual water and agreed operating conditions.

NUTRIENT POLLUTION AND EUTROPHICATION

- 1** US EPA. Basic Information on Nutrient Pollution.
<https://www.epa.gov/nutrientpollution/basic-information-nutrient-pollution>
- 2** US EPA. Learn about Harmful Algae, Cyanobacteria and Cyanotoxins.
<https://www.epa.gov/habs/learn-about-harmful-algae-cyanobacteria-and-cyanotoxins>
- 3** US EPA. What Causes HABs.
<https://www.epa.gov/habs/what-causes-habs>
- 4** Paerl, H.W. (2009). Controlling Eutrophication along the Freshwater-Marine Continuum: Dual Nutrient (N and P) Reductions are Essential. *Estuaries and Coasts*, 32, 593-601.
<https://doi.org/10.1007/s12237-009-9158-8>

LAKE CASE STUDIES

- 5** King County. Lake Washington Story. Account of sewage diversion and lake recovery.
<https://kingcounty.gov/en/dept/dnrp/nature-recreation/environment-ecology-conservation/watersheds/lakes/lake-washington/lake-washington-story>
- 6** Schindler, D.W. et al. (2008). Eutrophication of lakes cannot be controlled by reducing nitrogen input: Results of a 37-year whole-ecosystem experiment. *PNAS*, 105, 11254-11258.
<https://doi.org/10.1073/pnas.0805108105>

- 7** NOAA (2014). NOAA Forecasts Support Response to Lake Erie Harmful Algal Bloom.
<https://oceanservice.noaa.gov/news/aug14/lake-erie-hab.html>
- 8** NOAA (2015). NOAA, partners start early season forecast updates for Lake Erie harmful algal blooms.
<https://www.noaa.gov/media-release/noaa-partners-start-early-season-forecast-updates-for-lake-erie-harmful-algal-blooms>

PHOSPHORUS SOURCES AND INDUSTRIAL STREAMS

- 9** US EPA. Sources and Solutions. Nutrient-pollution source categories.
<https://www.epa.gov/nutrientpollution/sources-and-solutions>
- 10** US EPA (2004). Technical Development Document for the Meat and Poultry Products Point Source Category. Section 7, phosphorus sources and forms.
<https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P1001576.TXT>

REGENERATION RESEARCH

- 11** Kunaschk, M. et al. (2015). Novel regeneration method for phosphate loaded granular ferric (hydr)oxide - A contribution to phosphorus recycling. *Water Research*, 71, 219-226.
<https://doi.org/10.1016/j.watres.2015.01.001>

- 12** Huang, Y. et al. (2026). Post-regeneration neutralization enables stable phosphate adsorption-desorption in Ca- and NOM-rich waters. *Water Research*, 307, 126731.
<https://doi.org/10.1016/j.watres.2026.126731>

NUTRIENT REUSE IN AGRICULTURE

- 13** Ayers, R.S. and Westcot, D.W. (1985). *Water Quality for Agriculture*. FAO Irrigation and Drainage Paper 29 Rev. 1.
<https://www.fao.org/4/t0234e/T0234E01.htm>
- 16** MgO recovery studies: Critical conditions of struvite growth and recovery using MgO in pilot scale crystallization plant (2020); Struvite precipitation in wastewater treatment plants anaerobic digestion supernatants using a magnesium oxide by-product (2023).
<https://pubmed.ncbi.nlm.nih.gov/37207781/>
- 17** University of Minnesota Extension. Magnesium for crop production.
<https://extension.umn.edu/agriculture/crop-production/nutrient-management-for-minnesota-crops/magnesium-for-crop-production>

DRINKING-WATER AND BUILDING WATER SYSTEMS

- 14** US EPA. Why do water systems add phosphate to drinking water?
<https://www.epa.gov/lead/why-do-water-systems-add-phosphate-drinking-water-what-are-health-effects-drinking-water>
- 15** CDC (2025). Controlling Legionella in Potable Water Systems.
<https://www.cdc.gov/control-legionella/php/toolkit/potable-water-systems-module.html>