



PIPE FLOW TECHNOLOGY CENTRE™

Serving the Global Mining Industry

ABOUT SRC

The Saskatchewan Research Council (SRC) is one of Canada's leading providers of applied research, development and demonstration (RD&D), and technology commercialization. SRC has 70 years of RD&D experience, over 350 employees and provides products and services to its 1,500 clients around the world.

About SRC's Pipe Flow Technology Centre™

Serving the mining and oil and gas industries, SRC's Pipe Flow Technology Centre™ helps resource developers minimize their environmental footprint through applied technological research in extracting, transporting, processing and tailings management of complex mixtures. We conduct commercial-scale studies to develop safe and cost-effective solutions for our clients.

SRC's RD&D in pipe flow technology helps resource industries expand the horizons of how and where they operate in the areas of:

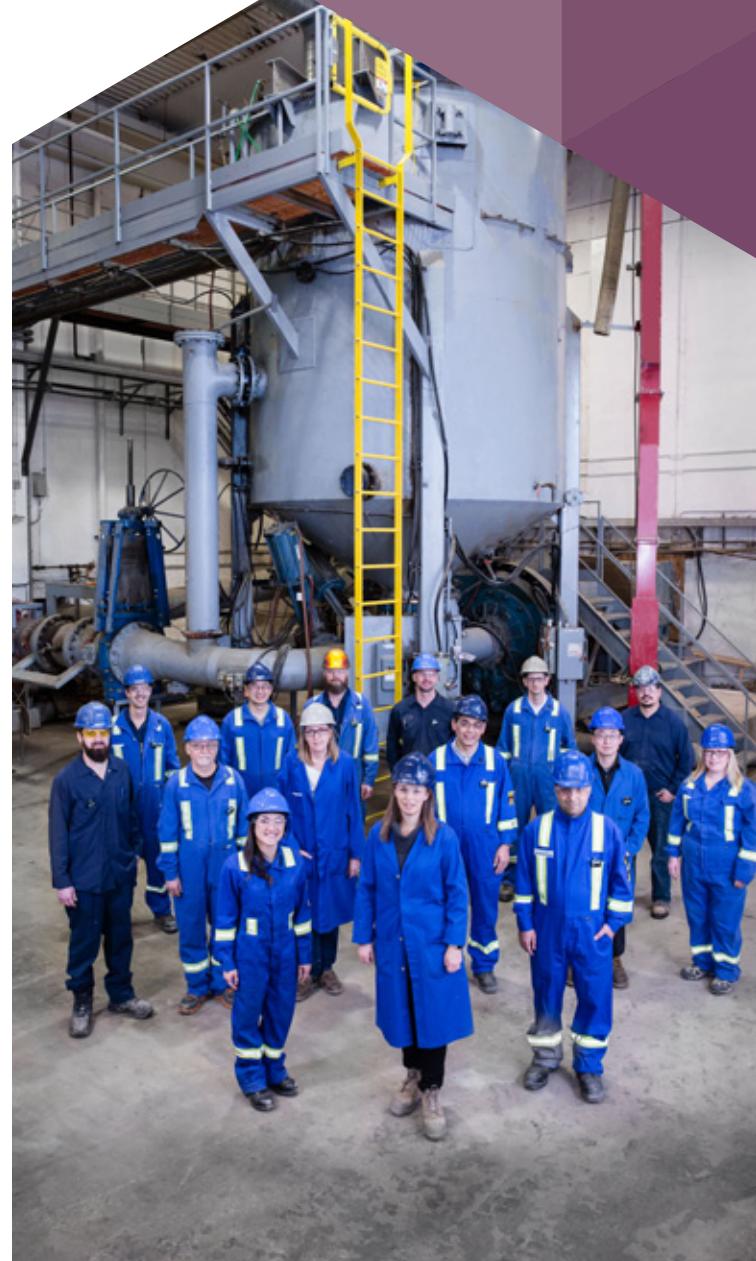
- Extraction
- Transportation
- Processing
- Tailings Management

Our work ranges from RD&D projects to applied industrial projects, spanning from small, bench-scale to commercial-scale pilots for:

- Uranium
- Potash
- Diamonds
- Gold, Base Metals and Other Minerals
- Oil Sands
- Oil and Gas

Our clients, large and small, understand how the power of pipe flow technology can transform the way they do business. Founded in 1960, we have collaborated with Canada's resource industries on a range of ground-breaking pipeline and fluid mechanics applications. Over the years, we've addressed industry needs by broadening our services to new areas. Examples of our expertise include:

- Hydrotransport of oil sand slurries to enable remote mining
- Paste backfill disposal of industrial tailings
- High-temperature processes
- Pipeline integrity systems testing
- Industrial water treatment
- Horizontal well recovery and production of heavy oil



The Pipe Flow Technology Centre™ Team



Shook-Gillies High-Pressure, High-Temperature Flow Loop

Facilities

SRC's Pipe Flow Technology Centre™ is equipped to enable full-scale physical modelling of the fluid mechanics pipe flow behavior of slurries and other complex mixtures. Actual pipe flow conditions are obtained in a laboratory environment where temperature, flow rate and mixture composition can be controlled and instrument performance can be optimized.

OUR FACILITIES

• Pipe Flow Test Facility – 2,200 m²

- Fully instrumented, temperature-controlled pipeline test loops suitable for flow testing of slurries, petroleum mixtures and pastes
 - 50 to 500 mm diameter horizontal flow loops
 - 20 and 50 mm diameter vertical flow loops
- Oil sand slurry preparation facility that can handle 20-tonne batches of ore
- Fully instrumented centrifugal pump test stand with drives up to 600 hp (expandable to 2,000 hp).
- Bench-scale lab equipment, including various viscometers and solids characterization equipment
- Plant space and equipment to test a wide range of pilot-scale processing equipment
- Advanced flow mapping tools, including densitometers, probes and state-of-the-art tomography instruments

• Tailings Test Facility – 500 m²

- Dedicated facility for tailings and industrial water treatment projects
- Key experimental equipment includes:
 - 30 m³ supply tank
 - Static segregation columns
 - Open channel flumes (8 m and 15 m in length), equipped with instrumentation to detect density variations in test materials

• The Shook-Gillies HPHT Test Facility – 160 m²

- 100 mm diameter Class 600 ANSI high-pressure, high-temperature flow loop housed in a Class 1, Division 1 building capable of handling volatile materials; system is designed to test industrial conditions, including slurry fluid flows from enhanced oil recovery projects involving solvent or steam
- Testing at temperatures up to 250 C, which will allow the system to simulate SAGD field conditions
- Testing at pressures of up to 1,300 psig, to reproduce conditions seen in large oil transmission pipelines

HYDROTRANSPORT

SRC's Pipe Flow Technology Centre™ provides test facilities and expertise for researching and developing slurry handling systems and applications. Clients from the mining, oil sands and oil industries use our internationally recognized facility to obtain quality pipeline data necessary for designing safe and reliable slurry pipelines.

Our employees offer an unparalleled degree of experience in developing practical pipeline solutions for our clients. We have collaborative relationships with the University of Saskatchewan, University of Alberta Department of Chemical Engineering and other international experts and institutions. We have developed a computer-based flow model suitable for many applications and offer training courses to instruct proper use of the model.

EXPERTISE

- Slurry applications
 - Slurry pipeline flow testing and modelling
 - Pump and instrumentation testing
 - Pipeline erosion testing
- Training
 - Slurry pipeline systems course
 - Multi-species model course
 - Custom, on-site training
- Pipeline operations troubleshooting and consulting
- Slurry process piloting and demonstration
- Oil-water pipeline testing
- Lab services:
 - Viscometry
 - Particle Size Distributions
 - Solids Density
 - Bench-Scale Testing
 - Methylene Blue Index Testing
- Advanced instrumentation:
 - Electrical Capacitance Tomography (ECT)
 - Electrical Resistance Tomography (ERT)
 - Gamma Ray Tomography (GRT)

COMPLEMENTARY SERVICES AT SRC

- Analytical test services, including water analysis and Dean-Stark
- Engineering design support for experimental equipment design, construction and modification
- Specialty equipment and system integration
- Sensor system development and integration



Lab Services Include Our Concentric Cylinder Viscometry Service



Experimental Work Platform for Conveyor Operation –
Designed and Built In-house



Pilot-Scale Hydrocyclone and Thickener Equipment Pilot



Lab-Scale Thickener Operation

PROCESS TESTING | EQUIPMENT AND INSTRUMENTATION PILOTING

SRC has worked on processing projects for many decades. Expertise in the area is captured within SRC among many groups, including the Pipe Flow Technology Centre™. Work can range from bench-top tests to industrial-size pilot plant-scale and field trials. The experience of SRC's pipe flow team, combined with SRC's broad base of specialists, enables the organization to develop unique and comprehensive solutions in one convenient location for industry in Saskatchewan and around the world.

SRC's Pipe Flow Technology Centre™ works with mining and oil and gas companies to develop knowledge and technology that increases efficiency and decreases costs, and puts a focus on safety and environmental protection.

EXPERTISE

- Processing:

Our team has worked with many producers and technology developers on piloting process equipment. The facility has the pumps, tanks, instrumentation and materials handling

capabilities necessary for process equipment testing, as well as expertise in conducting controlled experimental programs. Past programs have involved multiple components to prepare sample materials, test processes and evaluate outputs.

- Ore conditioning
- Separation, including hydrocyclones and flotation cells
- Mixing
- Broad mineral processing experience
- Fluid flow induced wear
- In-line flocculation
- Thickeners
- Advanced instrumentation and monitoring:
 - Flowmeter
 - Viscometer
 - Tomography
 - Sampling

EQUIPMENT AND INSTRUMENTATION PILOT TESTING

SRC's Pipe Flow Technology Centre™ offers a comprehensive approach to testing, which ranges from selecting appropriate sizes for scaled equipment testing to conducting tests, troubleshooting and evaluating test results. Test programs are designed to simulate field conditions in a controlled environment, ensuring quality data measurement, as well as avoiding impacts to field operations.

KEY SERVICES

- Equipment testing and troubleshooting: hydrocyclones, heat exchangers, pumps and new pipe material
- Pipeline wear studies
- Instrumentation testing: flow monitoring, wear monitoring and advanced tools
- Pipeline integrity monitoring method development and pilot testing

COMPLEMENTARY SERVICES AT SRC

Clients can access a wide range of services across SRC to further assist with technology development requirements:

- Support for scoping and feasibility studies
- Sample preparation, including crushing and grinding
- Indicator mineral and trace element analysis
- Analytical test services for water and contaminants
- Control system and instrumentation development expertise
- Advanced tools including:
 - Electron microprobe
 - Scanning electron microscope
 - Laser Ablation Mass Spectrometer (LA-ICP-MS)
 - X-ray Fluorescence
 - X-ray Diffraction
 - QEMSCAN®
- Processing and metallurgical testing: preliminary, detailed and pilot plant tests



Test Programs are Designed to Simulate Field Conditions
in a Controlled Environment

TAILINGS MANAGEMENT AND INDUSTRIAL WATER TREATMENT

SRC's Pipe Flow Technology Centre™ includes 500 m² dedicated to tailings research. This facility houses a 30 m³ supply tank, deposition columns and a 15 m long x 0.75 m wide x 1.6 m high open channel flume, equipped with instrumentation to detect pore pressure and density variations in test materials.

Additional equipment includes a pilot-scale thickener, mini thickeners and a smaller 8 m long x 0.25 m wide x 0.5 m high adjustable angle flume apparatus.

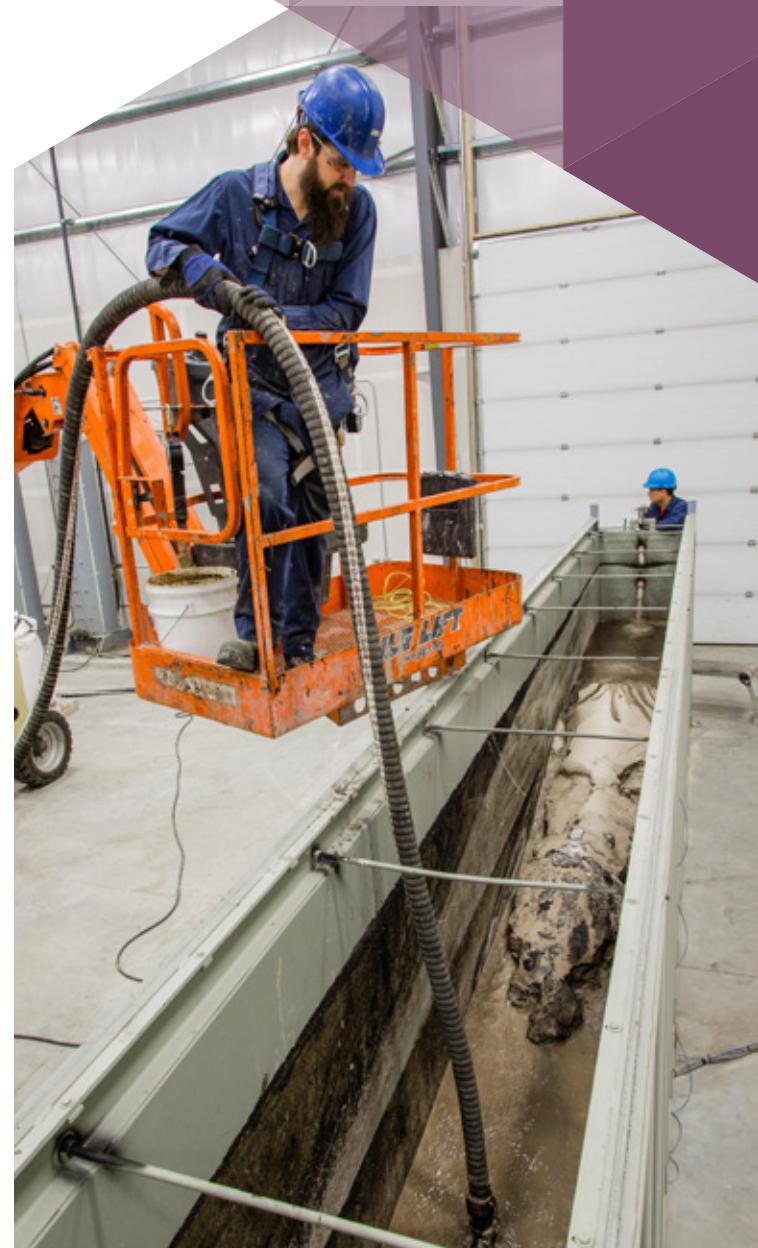
EXPERTISE

- Pipeline transport in both turbulent and laminar flow
- In-line flocculation methods
- Thickener piloting (lab and pilot-scale)
- Dewatering
- Consolidation and deposition
- Open channel flow
- Beaching
- Fines capture
- Lab techniques, including MBI and SFR
- Instrumentation piloting, testing and verification
- Industrial water treatment:
 - Adsorption technology development
 - Heavy metal contaminants removal

COMPLEMENTARY SERVICES AT SRC

Clients can access a wide range of services across SRC to further assist with technology development requirements:

- Environmental site assessment and remediation management
- Groundwater and surface water quality assessment
- Tailings post-processing recovery of uranium, heavy metals and rare earth elements
- Waste rock management
- Remediation planning with regulators
- Environmental testing and monitoring



Deposition of Thickened Tailings Slurry into SRC's Large Open Channel Flume

- Aerial image acquisition (Unoccupied Aerial Vehicle – UAV):
 - High-resolution image acquisition/GPS
 - Image processing services
 - Volumetric calculations
 - Digital terrain data
- Automated environmental monitoring systems:
 - Remote northern weather stations
 - Weather stations for airports in remote mines
 - Automated weather monitoring systems for mines



Services for every stage of the mining cycle.



Geoscience *Exploration* *Extraction* *Processing* *Tailings/Water Management* *Remediation*



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