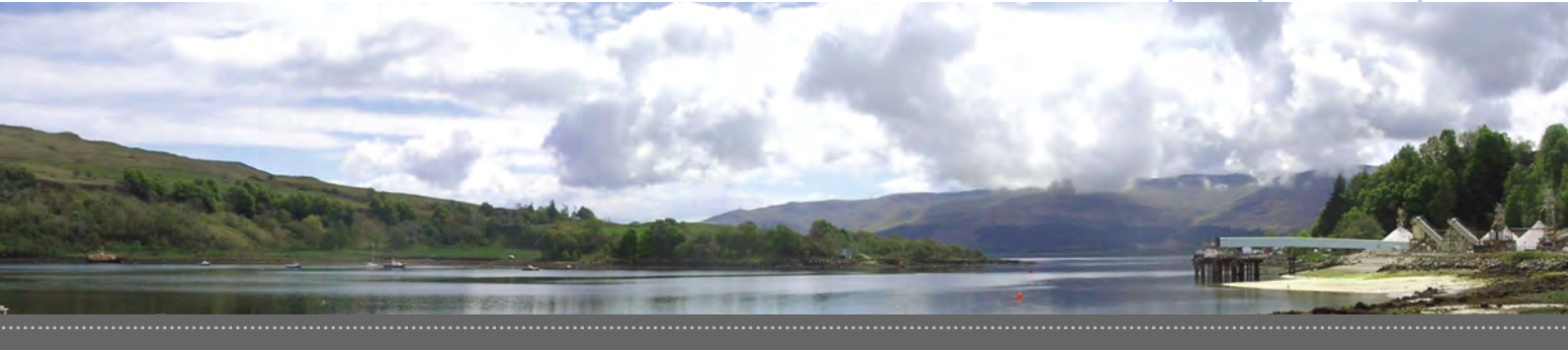


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# Leaders in Slurry Systems Engineering



CAPE TOWN • JOHANNESBURG • SANTIAGO • DENVER



Paterson & Cooke is a world leader in slurry technology. Since our formation in 1991, we have consistently provided technologically superior slurry handling systems for projects located throughout the world.

Our service capability includes the following key areas of expertise:

- Slurry testing services – behaviour analysis, sedimentation tests, rheology, wear rates, pump performance and pipe loop tests.
- Thickener circuit design – unit sizing and selection, control philosophy, water recovery estimates.
- Pipeline design – slurry flow modelling, steady state and transient flow, stress analysis, route selection.
- System engineering – detailed design and engineering of slurry preparation plants, pump stations and pipelines.
- Construction supervision and commissioning.
- Pilot plant facility design and operation.
- Equipment development, design and evaluation.
- Design reviews and system optimization.
- Specialized training courses.



*Our strength lies in the expertise, intellect and dedication of the people who work for Paterson & Cooke*

*Paterson & Cooke es líder mundial en tecnología de transporte de pulpas. Desde nuestra formación en 1991, hemos provisto consistentemente de sistemas de manejo de pulpas tecnológicamente superiores para diversos proyectos localizados alrededor del mundo.*

Nuestra capacidad de servicios incluye las siguientes áreas de experiencia y conocimiento:

- Ensayos de laboratorio – reología, pruebas en loop de tuberías.
- Diseño de circuitos de espesamiento – dimensionamiento, filosofía de control.
- Diseño de conducciones en tubería – modelación, análisis hidráulico.
- Ingeniería de sistemas – ingeniería de detalles estaciones de bombeo y conducciones en tubería.
- Supervisión durante la construcción y asistencia en la puesta en marcha.
- Diseño y operación de plantas piloto.
- Desarrollo, diseño y operación de equipos.
- Revisión de diseños y optimización de sistemas.
- Cursos de entrenamiento especializados.

# Tailings



Paterson & Cooke has designed and implemented numerous tailings pipeline systems throughout the world.

Key to the success of a reliable tailings pipeline system is the integration of the process plant variability and the transport system's flexibility to deal with a wide process design envelope. We have the skills and experience to take your tailings project from pre-feasibility to commissioning.

## Notable Projects

**Orapa Diamond Mine, Botswana:** The detailed design and commissioning of the new booster pump station to transport 35 000 t/d of kimberlite tailings to the storage facility. Six pumps in series per pipeline deliver tailings via 450 mm diameter pipelines to the tailings dam. The total installed power is 11.4 MW.

**Hillendale Mine, South Africa:** The hydraulic and process engineering design for the minerals sands tailings system. Two positive displacement pumps in parallel are required and generate a maximum pressure of 9 MPa to transport the material 4.9 km in a 300 mm high pressure unlined steel pipeline.

**Karee Mine, South Africa:** The detailed design, engineering and commissioning of a 6.5 km long tailings pumping system transporting platinum tailings using six centrifugal pumps in series.

**Phu Kham, Laos:** The detailed design, engineering and commissioning assistance of a 3.5 km long gravity flow pipeline transporting 38 000 t/d of copper tailings in 700 mm diameter pipelines.

*Paterson & Cooke ha diseñado e implementado numerosos sistemas de conducción de relaves en tubería alrededor del mundo.*

*La clave del éxito en sistemas confiables de transporte de relaves en tubería es la integración de la variación de la planta de proceso y la flexibilidad del sistema de transporte para cumplir con una envolvente amplia de escenarios de proceso. Tenemos las herramientas y la experiencia para desarrollar sus proyectos de relaves desde la etapa de pre-factibilidad hasta la puesta en operación de la planta.*

# Paste and Thickened Tailings



Key to a successful paste and thickened tailings system is a fundamental understanding of the preparation requirements, particularly when clays are present. We offer specialist analysis, consulting and training to provide a better understanding of the behaviour of clay containing mineral ores for improving mining, metallurgical and environmental process efficiencies. Paterson & Cooke has considerable experience in the dewatering and pumping of high concentration paste and thickened tailings systems.



*La clave del éxito de un sistema de pasta o relaves espesados es un apropiado entendimiento de los requerimientos de preparación, particularmente cuando existen arcillas.*

*Paterson & Cooke ofrece un análisis, consultoría y entrenamiento especializado, de modo de proveer un mejor entendimiento del comportamiento de las arcillas (comportamiento coloidal), de manera tal de mejorar la eficiencia de los distintos procesos.*

*Somos líderes mundiales en el diseño e implementación de sistemas de bombeo de relaves espesados y en pasta. Nuestra experiencia en el diseño de este tipo de sistemas ha sido desarrollada a través de más de 18 años, permaneciendo siempre a la cabeza del desarrollo tecnológico de este tipo de sistemas de preparación y transporte.*

# Paste and Thickened Tailings



We are world leaders in the design and implementation of high density paste and thickened tailings pumping systems. Our expertise in the design of paste and thickened tailings pumping systems has been developed over more than 18 years. We remain at the forefront of developing paste and thickened tailings pipeline transport technology.

## Notable Projects

**Minera Esperanza, Chile:** Review of design, test work and front end engineering of a 100 000 t/d thickened tailings disposal system.

**De Beers Kimberley Mines Combined Treatment Plant, South Africa:** Paterson & Cooke completed test work and front end engineering for a thickened tailings disposal system incorporating three positive displacement pumps. The high density tailings are transported 5.5 km with a maximum pump discharge pressure of 12 MPa. The system was commissioned in 2002.

**Rusal, Ukraine:** Paterson & Cooke completed the basic pump and pipeline specification for Rusal's Nikolaev Alumina Plant Red Mud Handling System. Two positive displacement pumps, each with a discharge pressure of 11.8 MPa are used to pump the red mud to the storage facility.

**Yanacocha, Peru:** Test work, detailed design, construction and commissioning assistance of a 15 000 t/d mill tailings pumping system. The tailings are thickened to a maximum solids concentration of 71% prior to deposition to reduce the amount of water in the storage facility, the embankments of which are formed by an active leach pad.

**Anglo Platinum, South Africa:** Manufacture, supply and operation of a paste thickening pilot plant for conducting on-site paste thickener pilot trials.

**Mutanda Mining, DRC:** Metallurgical pilot plant tests conducted for a paste thickener CCD circuit.

**Orapa Diamond Mine, Botswana:** Paterson & Cooke conducted a mine wide water recovery efficiency comparison between two full scale gravity thickening systems that considered Paste thickeners and Ultra High Rate thickeners. The results of the comparison were used to motivate the design of a new thickening system for the mine upgrade that would reduce mine water consumption.

# Backfill



The design of deep level backfill distribution systems for hydraulic and paste backfill systems was revolutionised by Paterson & Cooke's full flow design methodology. Pioneered 18 years ago, this technology is now widely recognised as the correct design method for backfill systems. Early backfill systems were often characterised by high pipeline wear rates and excessive downtime and these problems are overcome by a fundamental understanding of backfill flow behaviour and pipeline hydraulics.

## Notable Projects

**Cleveland Potash Mine, United Kingdom:** Detailed engineering and commissioning of a 1 km deep and 11 km horizontal potash backfill system. The paste plant utilises a novel viscosity based control system developed by Paterson & Cooke. High pressure energy dissipators, developed by Paterson & Cooke, allow the system to start up and shut down in a controlled manner ensuring that the system always operates under full flow conditions.

**Las Cenizas, Chile:** The hydraulic and process engineering design for the paste backfill system. Two positive displacement pumps in parallel are required, and generate a maximum pressure of 8.5 MPa.

**Raposos Mine, Brazil:** System analysis and design, as well as material testing and modelling, of Raposos Mine backfill pipeline distribution system for Mineração Morro Velho in Brazil. Paterson & Cooke supervised pipeline pressure gradient tests at Queiroz metallurgical plant, Brazil.

**Lisheen Mine, Ireland:** Test work, hydraulic design, front end engineering and commissioning of the pumped paste fill system transporting 3 300 t/d of paste.

*El diseño de sistemas de llenado de minas subterráneas profundas fue revolucionado por la metodología de diseño a "flujo completo" desarrollada por Paterson & Cooke. Pioneros hace 18 años, esta tecnología es ahora ampliamente reconocida a nivel mundial como el método de diseño más apropiado para llenado de minas subterráneas. Los primeros sistemas de llenado de minas subterráneas se caracterizaron por desgaste excesivo de las tuberías y reiteradas interrupciones en la operación. Estos problemas han sido superados gracias al apropiado entendimiento del comportamiento del flujo y de la hidráulica de tuberías en este tipo de sistemas.*

# Long Distance Pipelines



Long distance slurry pipeline transport is a proven technology and is now widely accepted as a viable alternative to conventional bulk transport. Key to the success of a long distance system is minimising operating costs by determining the optimum grinding requirements for pipeline transport. The optimum particle size distribution results in lower transport velocities and reduced pipeline wear rates. We have completed numerous test work campaigns and bankable feasibility studies for long distance systems and have completed the front end design and engineering of several long distance projects in conjunction with strategic partners.

## Notable Projects

**Caserones Concentrate Pipeline, Chile:** Preliminary design of the Caserones Mine copper concentrate pipeline.

**Ramu Nickel Laterite Ore Pipeline, Papua New Guinea:** Review of feasibility study, supervision of test work in China, and detailed hydraulic design for the 120 km long ore pipeline from the mine site to the process plant.

**Pebble Mine, Alaska:** Bankable feasibility study for the 140 km long proposed copper/gold concentrate pipeline from Pebble Mine to Anchorage.

**Ambatovy, Madagascar:** Bankable feasibility study, test work and route survey for the 234 km long Ambatovy nickel laterite pipeline.

**OCP Morocco:** Review, feasibility study and cost estimate of a 200 km long phosphate pipeline.

**Minera Esperanza, Chile:** Review of design of concentrate pipeline and supporting rheology test work.

*El transporte hidráulico a través de tuberías de gran longitud es una tecnología probada y ampliamente aceptada como alternativa al transporte de sólidos convencional. La clave del éxito de un sistema de transporte de gran longitud es minimizar los costos de operación mediante la determinación del nivel de molienda óptimo para el transporte en tuberías. La distribución de partículas óptima resulta en una menor velocidad de transporte y menores tasas de desgaste. Hemos desarrollado numerosas campañas de ensayos y estudios bancables de factibilidad para sistemas de tuberías de gran longitud, además de haber ya diseñado y detallado muchos sistemas en conjunto con socios estratégicos.*

# Marine



Offshore mining presents many challenges and the undersea hoisting of ore from the sea bed to the mining vessels is crucial to such operations. We have done extensive work on the design of offshore pumping systems using air lift pumps, remotely operated vehicles and conventional centrifugal pumping. Dredging, sand bypass systems and beach replenishment require a thorough understanding of the material transport requirements and correct equipment selection for the marine environment. Our extensive test facilities provide the necessary information needed for the design of robust marine slurry transport systems.

## Notable Projects

**Namdeb, Namibia:** Development, test work and design of a novel elutriator to classify dredge material to maximise the processing capacity of the floating diamond treatment plant.

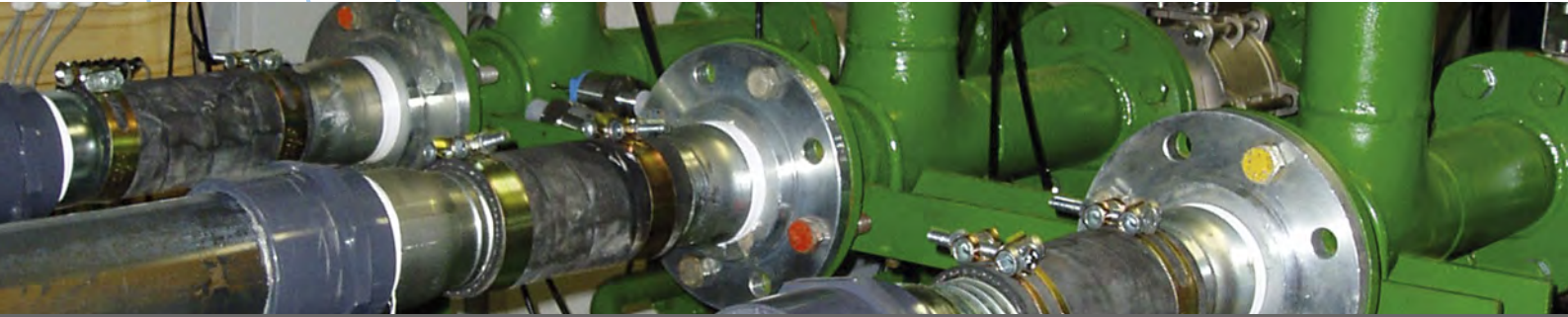
**De Beers Marine, South Africa:** Development, test work and detailed engineering of novel high capacity dewatering bins for an offshore mining vessel. The bins are emptied using proprietary fluidisers which deliver a controlled feed to the on-board process plant.

**Coega Harbour Sand Bypass System, South Africa:** Paterson & Cooke was responsible for the commissioning of a fixed sand bypass system for the new Coega Harbour, designed by others. Our work included the commissioning of water pumps, jet pumps, sand transport pumps and pipeline as well as modification of the control system. We provided further assistance with system improvements and maintenance issues.

**Durban Harbour Temporary Sand Bypass System, South Africa:** Design, engineering and specification of pumping and piping systems for the reclaim pipeline from a dredger into a temporary storage bund, with a temporary pump feeding into an existing beach sand feeding system.

*La minería de altamar presenta muchos desafíos y el izaje del mineral desde el fondo marino es crucial en dichas operaciones. Paterson & Cooke ha desarrollado un intenso trabajo en el diseño de sistemas de bombeo para estos fines usando diferentes técnicas y tecnologías. Los sistemas de izaje y de creación de playas requieren un completo entendimiento hidráulico y una selección apropiada de equipos considerando el ambiente costero. Nuestras instalaciones para pruebas nos permiten obtener la información necesaria para el diseño de sistemas de transporte de pulpa robustos para el ambiente marino.*

# Hydraulic Hoisting



Hydraulic hoisting has the potential to be one of the most cost effective methods of transporting ore from underground to surface. We have been involved in the analysis of a number of proposed hydraulic hoisting systems and can advise clients on ore feeder techniques and perform hydraulic and engineering analysis of hydraulic hoisting systems.

## Notable Projects

**Getchell Mine, Nevada, USA:** Definitive cost estimates for the hydraulic hoisting of ore for Placer Dome's Getchell Mine in Nevada, USA. The study identified potential to combine the mine de-watering system with the hydraulic ore hoisting system by using high pressure positive displacement slurry pumps underground.

**Anglo Platinum, South Africa:** Feasibility study and cost estimate for the underground hydraulic hoisting of 3 300 t/d of -13 mm ore from underground workings to the surface using a three chamber pipe feeder energy recovery system.

**Musselwhite Mine, Canada:** Technical review of hydraulic hoisting technology for Placer Dome, Canada. As a result of the technical review we completed a preliminary design, feasibility study and cost estimate for a proposed hard rock hydraulic hoisting system for Musselwhite Mine.

**Mineração Morro Velho, Brazil:** Technical evaluation of the proposed Siemag three chamber pipe feeder hydraulic hoisting system for Mina Grande gold mine. The scope of work included the evaluation of wear resistant materials for the proposed hydrohoist system, prediction of pipeline wear rates, measurement of pipeline pressure gradients and analysis of the hydraulic performance of the system.

*El izaje hidráulico de sólidos tiene el potencial de ser unos de los métodos económicamente más efectivos para transportar el mineral desde la mina subterránea hasta la superficie. Paterson & Cooke ha participado en el análisis de un gran número de sistemas de izaje hidráulico y puede aconsejar a los clientes acerca de técnicas de alimentación de mineral, así como desarrollar análisis hidráulicos o diseño de ingeniería de este tipo de sistemas.*

# Review and System Optimisation



Design audits are needed for a number of reasons: confirmation of a proposed or alternative design by a third party, troubleshooting the operation of an existing system or the inspection of the causes and failures of an existing process.

The nature of the design auditing process requires that all parties be fully informed of the scope of the investigation and reasons for the study. Paterson & Cooke is able to act as the client's representative and can conduct on site audits of all slurry preparation and handling facilities. We have a wide range of portable equipment that can be used to gather data on thickener operation as well as pump and pipeline performance, including transient events.

## Notable Projects

**Syncrude, Canada:** Cold eyes review of North and Aurora mine hydrotransport and tailings pumping systems to optimise system reliability.

**Petro Canada, Canada:** Hydraulic design calculation review of the Fort Hills hydrotransport and slurry pipeline systems.

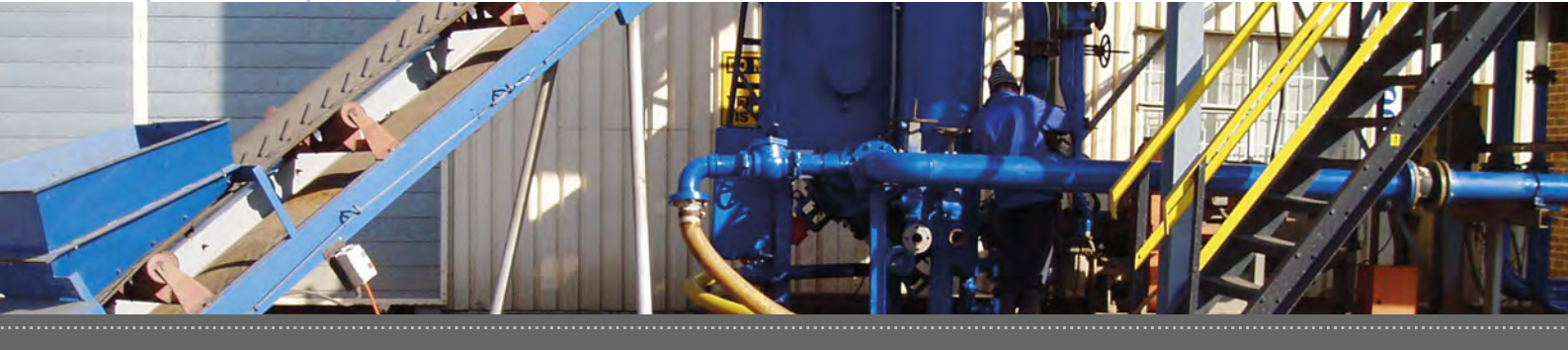
**Esperanza, Chile:** Hydraulic design review of 140 km long concentrate pipeline and thickened tailings disposal system for the 100 000 t/d Esperanza Mine.

**Ramu Nickel Laterite Pipeline, Papua New Guinea:** Review of the bankable feasibility study of the initial design of the 120 km long laterite ore pipeline.

*Las revisiones a los diseños pueden requerirse por un gran número de razones: confirmación de una alternativa de diseño por terceros, corregir problemas de operación de un sistema existente o la inspección de las causas de las fallas de un sistema existente.*

*Paterson & Cooke actúa como representante del cliente cuidando que la naturaleza, razones y alcances de la auditoría de proceso sean claramente informados a todas las partes. Desarrollamos revisiones en terreno de todas las instalaciones que conforman una planta de procesos con pulpas. Además contamos con un amplio número de equipos transportables que pueden ser usados para obtener información de la operación de espesadores o del desempeño de equipos de bombeo o sistemas de tuberías, incluyendo eventos de tipo transiente.*

# Laboratory and Pilot Testing Facilities



Our extensive laboratory facilities allow us to perform all the tests required to establish design parameters for slurry pipeline systems and solid-liquid separation equipment. Our test work capability ranges from small bench top test work to large scale pilot plant and pipe loop tests.

Our facilities include:

- Rotational and tube viscometers.
- 40 mm to 250 mm diameter fully instrumented pipe loops.
- Pump performance testing.
- Pipeline wear tests.
- Bench and pilot scale thickening equipment.
- Process equipment development and evaluation.



*Nuestras instalaciones para pruebas nos permiten desarrollar todos los ensayos requeridos para determinar los parámetros de diseño para sistemas de transporte de pulpas en tubería y/o sistemas de separación sólido/líquido. Nuestro rango de trabajo va desde ensayos a escala de laboratorio hasta plantas piloto a gran escala y loop de tuberías.*

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# Courses and Training



We are committed to sharing our specialist knowledge and skills by hosting courses which provide participants with a sound theoretical and practical understanding of dewatering, slurry pipeline and paste technology.

We regularly present courses on the following topics:

- Slurry Pipeline Design / *Diseño de conducciones de pulpa en tuberías.*
- Dewatering / *Espesamiento.*
- Paste and Thickened Tailings / *Relaves espesados y en pasta.*

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