Our key strength is the intellect, creativity and commitment of the people who work for Paterson & Cooke
The Mine Backfill Group

Paterson & Cooke is a recognised leader in the design and implementation of mine backfill systems and associated processes. Since its formation in 1991, Paterson & Cooke has consistently provided technologically advanced systems for projects located throughout the world. Through its worldwide network of offices, Paterson & Cooke provides leading edge engineering and material testing services, enabling the development of design solutions founded through knowledge and experience.

Mine backfill, and in particular backfill using hydraulic or paste tailings, is now a well-established and proven practice within the underground mining industry. Notwithstanding mine backfills’ role as part of a forward looking integrated waste management strategy, the application of the technology offers the opportunity to convert resource into reserve, reduce dilution, improve underground working conditions and ultimately improve the commercial indicators of a project.

From its roots in slurry transport technology, Paterson & Cooke has become a leader in understanding and designing pump and pipeline systems for the safe and efficient reticulation of hydraulic and paste fills. This experience and capability has been expanded to accommodate backfill and paste fill plants, combining the preparation and transportation functions within a single design scope.

Through the application of its world class laboratory facilities, Paterson & Cooke is able to comprehensively characterise and quantify tailings or other materials utilised in a backfill project to ensure the design is both reflective of the material specifics and accommodating of natural variability in material properties.

Paterson & Cooke has completed backfill system designs and studies across a wide spectrum of material types, locations and requirements, utilising the knowledge and experience of professionals located across the world. Operating as a global team, the Paterson & Cooke Backfill Group offers a total solution to your backfill needs and requirements. This group includes process, mechanical, chemical and mining engineers and technologists drawn from a wide range of academic and operational backgrounds to provide a focused group of professionals committed to the development of industry leading backfill solutions.
Laboratory Services

Through its network of laboratory testing centres in Canada, Chile, South Africa and the USA, Paterson & Cooke offers an unrivalled capacity to characterise and understand backfill materials, providing essential data as a foundation in a backfill system design. Paterson & Cooke uses industry standard and proprietary techniques to appreciate the characteristics and nuances of a material, recognising that as no two materials are alike, neither are two system designs.

The testing services offered by Paterson & Cooke include material characterisation, equipment capability assessment, rheological and flow behaviour characterization and backfill recipe and strength testing.

Material Characterisation

Knowing the slurry components is essential in order to understand the behaviour of the slurry. Material characterisation includes not only the basic physical properties of the slurry but also the mineralogy of the solids and the chemical quality of the water. Combined with our in depth understanding of clay mineral properties, it provides an essential tool for predicting the dewatering and flow properties of the backfill product.

Material characterisation work performed by Paterson & Cooke includes:

- Coarse particle size distribution (PSD) via sieve analysis;
- Fine particle size distribution (PSD) via laser diffraction;
- Specific gravity testing using helium pycnometry;
- pH and turbidity of process streams; and mineralogy, whole rock analysis (WRA), sulphur content and water chemistry (subcontracted).

Vacuum and Pressure Filtration

Filtration is often a critical component of backfill mixture preparations and the options and solutions for this phase in the process are wide, thus making the correct selection of equipment type and capacity crucial to the operability of the final plant. Paterson & Cooke offer a range of testing to assess the performance of both vacuum and pressure filtration systems, enabling selection and specification of the most suitable and proven equipment to compliment the rest of the design, as well as enabling independent verification of equipment vendor testing.
Cyclone Testing and Evaluation

The ability to modify the size distribution of a tailings stream to optimise backfill performance, either for hydraulic or paste fills is an opportunity not to be overlooked when evaluating a materials’ performance as a backfill. Paterson & Cooke has the capacity to trial cyclone performance and modify size distributions to explore any such opportunities or advantages. These pilot tests have proven themselves to be valuable when used in a pre-commissioning format; the optimal cyclone settings can be established in the laboratory ahead of full scale commissioning to save weeks of fine tuning on site.

Thickener Dewatering

Paterson & Cooke applies a step wise approach to dewatering test work at both bench-top and pilot plant scale levels. This includes determining the correct thickener feed conditions; the thickener throughput limits and the sedimentation/compaction characteristics of the slurry. This data together with the proprietary SteadyBed™ thickener control system allows Paterson & Cooke to tailor the thickener to suit the backfill operational requirements.

The thickener testing conducted includes:
- Flocculent selection and dosage optimization;
- Feed density optimization; and
- Static column tests for thickener underflow density estimates.

Rheology and Slurry Transport

Understanding the rheological characteristics of a hydraulic or paste backfill is essential in the correct and appropriate design of a reticulation system; getting this right can be the difference between success or failure! Paterson & Cooke is at the forefront of rheological and hydraulic transportation testing and has been instrumental in developments in this field. Through state of the art in-house proprietary testing, Paterson & Cooke offers an industry leading capacity for assessing and then interpreting laboratory and field based test data to enable confidence in the design of slurry and backfill reticulation systems. Specifically the testing offered by Paterson & Cooke includes the following:
- Rheology and on site process viscometer measurements;
- Small and large scale pipe loop testing to establish friction losses, flow regimes, settling characteristics; and
- Relative and actual wear testing of pipelines.
Backfill Testing

Determination of the backfill characteristics in terms of strength, stiffness, setting time and recipe are fundamental in ensuring the final backfill product firstly achieves the necessary operational performance criteria and secondly in the most cost efficient way, especially as binder costs typically represent in excess of 60% of operating costs of a backfill system.

Paterson & Cooke has a proven record in the evaluation of backfills, enabling design engineers to tailor a project design to provide maximum performance at optimal cost. Testing typically involves a screening stage in which a range of recipes, including different water to binder ratios and binder types are assessed. Following identification of preferred mixture options, advanced testing over extended periods is completed to provide confidence in the performance of one or more recipes.

Additionally, backfill testing may include investigative assessment of operational backfill systems which are under-performing, and this again can include binder evaluations as well as geochemical and chemistry evaluations.

Typically testing offered within this scope includes:

- Test plan development;
- Binder quality control testing;
- Unconfined compressive strength (UCS) testing;
- Tri-axial strength testing;
- Hydraulic conductivity;
- Cemented Rock Fill testing (300 x 600mm);
- Splitting tensile; and
- Flexural (beam) testing.
Field Testing

Paterson & Cooke can offer a range of tests at project sites to cater for instances where restrictions on movement of materials prevents the completion of work in the laboratory.

Additionally, Paterson & Cooke can mobilise proprietary field scale flow loop and pilot plant thickener testing plants. The mobile flow loop is a self-contained, containerised unit which can be mobilised to site quickly, enabling larger scale hydraulic flow testing.

The pilot thickener unit can similarly be deployed at a project site to enable large scale, on stream continuous thickener testing, providing additional confidence and surety over full scale thickener selection and design capacity. Further, with continuous underflow production, the opportunity to conduct downstream pumping and deposition trials is also possible, with extended run times. This allows the assessment work to accommodate some of the uncertainty associated with material variability as well as natural process fluctuations.

Paterson & Cooke has also run field testing programs to evaluate existing reticulation system performance, either to improve performance, tailor maintenance programs or to obtain input data for system expansions.

Paterson & Cooke has observed how, through operator and owner involvement during such on site work, additional confidence in a project is achieved through familiarity and experience with the materials and equipment.
Engineering Services

Engineering services extend from an initial client discussion through to detailed design for final project execution, and Paterson & Cooke is positioned to offer services across this entire spectrum. From the initial enquiry and fact finding effort, Paterson & Cooke has experienced and qualified professionals to support each phase in the development of a project.

Conceptual Scoping and Prefeasibility Studies

These are often the first stage in the evaluation of a project, and can include fact finding site visits, options evaluations and assessments and extensive dialogue with operators and project leaders. The objective of these preliminary studies is to examine the role and requirements of backfill within a project, recognising that it cannot be examined in isolation, and appraisal of all associated inter-dependent functions is essential. This study approach is equally applicable to desk based assessments for green field projects and established operations looking to adopt backfill technologies.

Following the data gathering and assessment, Paterson & Cooke would typically aim to develop a series of options, recognising that there will often be multiple routes to a final solution, and with these identified, a trade off evaluation can be undertaken. Such an evaluation would typically be complete with input from the decision makers in a project so to ensure the selection of an optimum solution for a project.

Feasibility Studies

At this level it is expected that the broad outline of the project solution may be refined and thus can effectively be tested through the development of an engineering and commercial level of accuracy where an option’s feasibility can be assessed in the context of a project.

Feasibility studies may also be prepared for and on behalf of commercial institutions and can act as a basis of scrutiny for lending, or for stock-market purposes.

Paterson & Cooke has completed standalone feasibility studies or worked in cooperation with other design engineers to deliver project wide feasibility assessments.
Basic and Detailed Engineering
Advancing from a feasibility study, the basic engineering phase enables the freezing of a flow sheet and the design criteria and major equipment specifications. It also represents the stage at which final decisions on long-lead items may be made and initial payments to secure such items are placed.

With the flow sheet and other project specifics frozen, the detailed design phase commences and advances the design to the point of execution, including preparation of construction specifications and drawings, as well as assisting the project with the appointment of contractors and other significant equipment purchases.

Engineering Services Case Study - Dishaba Mine Paste Backfill Plant

Client:  
Anglo Platinum

Location:  
Northam, Limpopo, South Africa

Classification:  
Cemented Paste Backfill

Capacity:  
230 tph

Anglo Platinum’s Dishaba Mine is situated between the towns of Northam and Thabazimbi in the Limpopo Province in South Africa and forms part of the North Western Limb of the Bushveld Igneous Complex. Due to poor ground conditions, cemented backfill is considered to maintain an acceptable extraction rate. The scope of work included the design of a modular backfill plant and infrastructure, capable of supplying one mining level, filling five panels in four hours.

The backfill base material tailings is a combination of ISA milled Merensky and UG2 tailings. The scope of work further included the design of a satellite pump station to store and transfer tailings from the current tailings facilities to the backfill plant.

Between February 2011 and October 2012 Paterson & Cooke completed a study review, strength and flow behaviour test campaign, concept and feasibility design which included all engineering disciplines.
Backfill Operational Support

Paterson & Cooke’s field services team can meet your operational or in-field requirements with an experienced team of engineers and operators. Through a thorough knowledge of the designing and operating range of backfill systems, the team offers a unique ability to support construction, commissioning, operator training, as well as system maintenance and optimisation.

Construction Support and Commissioning

Construction is not simply building to drawings and specification, rather it also requires the realisation of the design intent to ensure the system can operate and function in line with the expectations of the design. The engagement of experienced construction supervisors and support staff enables on the ground interpretation of design drawings and specifications to ensure that the intent is realised.

Paterson & Cooke can support the construction phase of a programme from design review, to contractor support and if required, on site supervision as the clients representative.

With construction complete, the commissioning phase is essential to ensure the system operates to its fullest potential. It is also an opportunity to identify aspects of the design or construction which might be improved or optimised.

Paterson & Cooke provides support from construction reviews and snagging surveys, through to cold and then hot commissioning runs, culminating in formal performance sign offs once steady state operations are achieved.

Operator Training

Operator training is a cornerstone in the safety and effectiveness of a backfill operation. Often inclusive within the commissioning phase, operator training can include development of safe working procedures, and robust and dependable laboratory functions in support of an on-going Quality Assurance programme, backfill preparation plant and underground operations training, as well as support to mine planners and backfill engineering staff to enable an operation to achieve the very best from its backfill system.

Through a range of on-site and classroom based education and training programs, as well as “in operations” support, Paterson & Cooke’s experienced staff are able to provide for all start up and post commissioning training needs.
Backfill Management Planning
Paterson & Cooke can assist with the development and implementation of a comprehensive backfill management planning system, including operations, health and safety and maintenance. Often the introduction of backfill within a new or existing operation is a new technology and therefore the deployment of effective procedures and system to ensure safe, reliable and effective performance is essential.

System Audits, Optimisation and Expansion
Backfill technologies and practices have developed rapidly over the past two decades and often existing operations can benefit from system audits and performance reviews, which can identify areas of deficiency or improvements through the adoption of best practice. Such improvements might be to examine alternative binders or upgrades to equipment items which realise long-term cost savings and improve reliability.

Through the marriage of experienced operators and designers, Paterson & Cooke provides the necessary capability to audit, identify and recommend system improvements, quickly and in cooperation with an operation, to enable attainment of current and future needs. Often future needs require upgrades or expansion of existing systems. Paterson & Cooke can support these functions, recognising that rarely can an existing system be taken off line, and hence any proposed work must respect the on-going operation of the system and the extraction operations dependent on it.

Backfill Field Services Case Study - Efemçukuru
Client: Eldorado Gold Corp.
Location: Izmir Province, Turkey
Classification: Cemented Paste Backfill
Capacity: 50 tph

Eldorado Gold’s Efemçukuru is situated in Izmir Province, Turkey and is a high grade epithermal gold deposit. The ore is extracted using modern underground mechanised mining techniques, complimented with the use of cement paste backfill.

The scope of work included the detailed design and specification of the underground reticulation system followed by commissioning and operator training support once the plant had been constructed. Since then, Paterson & Cooke has provided regular support through operational management audits, development of plant operating manuals and continued staff training and development.
Konkola Mine, Zambia: Paterson & Cooke undertook an extended project and site infrastructure audit, in tandem with a review of the project life of mine expectations. The outcome was a step wise execution plan to instigate and progressively expand a backfill system in support of the life of mine requirements.

Kidd Creek Mine, Canada: Paterson & Cooke hydraulically modelled the expansion to this 400 tph paste distribution system and we continue to support the mine with regular audits, updates to rheology monitoring, test work and technical support.

Snap Lake, Canada: Plant upgrades and technical support including dewatering system audits, rheological consulting, hydraulic modelling of the underground distribution, commissioning, start up and training of operators.

Dishaba Mine, South Africa: Backfill strength test campaign, de-watering and flow behaviour tests, and the completion of the feasibility study and front end design of the paste preparation plant and underground reticulation system.

Vale’s Backfill Operations, Canada: Vale is one client in particular who has relied on Paterson & Cooke to cover hydraulic fill modelling (including the software development), tailings optimization for the Sudbury basin, laboratory testing, reliability audits of most of their backfill systems and backfill support studies for their new mines. P&C is currently working on the FEL3 design for the Voisey’s Bay paste backfill system.

Barrick Gold Corp., North America: Paterson & Cooke has developed the underground distribution system standard for Barrick, designed the reticulation system and presented backfill workshops for its Goldstrike Mine in Nevada. Our work also extends to paste fill recipe improvement through cycloning and unique binder amendments for their Williams and Cortez Hills mines.

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

Cleveland Potash Mine, United Kingdom: Detailed engineering and commissioning of a 1 km deep and 11 km horizontal potash backfill system. High pressure energy dissipaters 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.
Courses and Training

Paterson & Cooke is consistently at the forefront of technological and research developments and utilizes this position to provide a range of educational courses for both designers and operators alike.

- **Mine Backfill System Design and Operation**: This one or two day workshop provides an overview of the issues impacting the design and operation of underground mine backfill systems.

- **Slurry Pipeline Design**: An annual slurry pipeline design course that provides delegates with a working knowledge of slurry pipe flow theory, and a practical overview of the requirements for the design of slurry pipeline systems.

- **Thickened and Paste Slurry Transportation**: A two day course focused on the fundamentals and practicalities of transporting paste and thickened tailings products.

- **Slurry Dewatering and Thickener Operation**: A two day course including lectures and laboratory demonstrations that introduce delegates to the fundamental concepts of tailings slurry behaviour, coagulation, flocculation and thickening and to apply these concepts to the selection and operation of thickening units.

- **Filtered, Paste and Thickened Tailings Course**: This four day course provides delegates with a thorough background to the field so that they are better equipped to successfully implement filtered, paste and thickened tailings systems.
Mine Backfill Publications


Mine Backfill Publications


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