OIL AND GAS SERVICES

Environmental
Linear Infrastructure Engineering
Site & Facilities Engineering
Surface Water
Groundwater
Site Assessment & Remediation

ENVIRONMENTAL, ENGINEERING AND GEOSCIENCE SERVICES
Klohn Crippen Berger Ltd. (KCB) is an international engineering, geoscience and environmental consulting firm with its head office in Vancouver and nine offices in strategic locations in Canada, Australia, Peru and Brazil. We are registered and have an ongoing presence in the United States, United Kingdom, Papua New Guinea, Indonesia, Mauritania, and Mongolia. We have a strong reputation for quality and technical expertise in a range of sector services including: Oil and Gas, Water, Power, Transportation and Mining. Since forming in 1951, we have a long history of participation in local projects, as well as a strong international reputation. We are working on some of the largest, most challenging projects, both nationally and internationally.

Our focus is the integration of the environment into engineering and social plans of our clients to build successful, sustainable projects. We minimize environmental effects and optimize opportunities to mitigate the environmental footprint of the project and maximize social benefits. Our environmental teams include specialists in: aquatic and terrestrial biology, geochemistry, limnology, meteorology, hydrology and groundwater, socio-economists, and project and program managers. We work with local environmental consultants and retain national and international experts to develop teams that meet the needs of the client, the community and the environment.
KCB's Alberta Group works on challenging projects in the oil sands developments, onshore and offshore oil and gas industry, traditional mining, infrastructure and water resources markets. Our projects include all aspects of hydrogeology and hydrotechnical, environmental and reclamation services, tailings management, dam designs, pipeline design and maintenance, offshore drilling islands and plant site foundation engineering.

Our Alberta operation services a wide variety of clients within Western and Northern Canada. We are based in four offices, Calgary, Edmonton and Saskatoon, which operate under an integrated management system consisting of quality, health and safety and environmental procedures. KCB works for some of the largest oil and gas and oil sands producers and we have ongoing projects with several respected mid-tier operators. Our engineers and scientists have project experience in arid and northern regions, and are familiar with the engineering design and environmental management requirements for conventional and unconventional oil and gas projects. We pride ourselves on being a technically strong consultancy with mature service delivery practices including inter-office and inter-group project collaboration. This latter element of our business is particularly advantageous as it permits us to efficiently provide multi-disciplinary engineering services including mechanical, electrical, civil, and structural engineering to our clients.

KEY SERVICES INCLUDE:

**Environmental** – community management planning and stakeholder consultation, community surveys, baseline and impact assessment, regulatory permitting and compliance, operational support and compliance reporting, site assessments and remediation, liability assessments and environmental management systems audits, risk assessments, and closure planning and reclamation.

**Linear Infrastructure Engineering** – geotechnical and civil engineering designs for railways, pipelines and related infrastructure, pipeline ROW and railroad alignment risk assessment and hazard management, powerline design and construction; design, construction and maintenance of access roads and bridges to wellsites and plant facilities.

**Site & Facility Engineering** – design, construction management and maintenance of site and plant access roads, design and installation of foundations for plant facilities including large storage tanks, surface water control designs and construction, design of water and slurry pump/pipeline systems and sand and gravel resource management.

**Surface Water** – site drainage and clean water diversions, site water balance, storage impoundment designs, construction management, operational and compliance performance monitoring, baseline characterization at regional and site scale, assessment of surface water impacts and mitigation design, and water chemistry modelling.

**Groundwater** – groundwater exploration, advanced numerical modelling of groundwater resources, bore field (water supply) design, installation and commissioning. Other key services include integrated groundwater quality and water balance modelling, wastewater injection assessment, design and permitting, design of groundwater monitoring networks for operational and regulatory compliance monitoring, and groundwater remedial designs. KCB also has experienced hydrogeologists in water policy and access processes.

**Our clients include:**
- Shell Canada Ltd
- Conoco-Phillips Canada
- Talisman Energy
- Apache Corporation
- Husky Energy Inc.
- Origin Energy Resources Limited
- AltaGas Processing Partnership Ltd
- AltaGas Ltd.
- TransCanada Pipelines Ltd.
- Pembina Pipeline Corporation
- Gibson Energy
- Twin Butte Energy Ltd.
- Keyera Corp.
- Baker Hughes Canada
- Japan Oil Sands Ltd.
- Blackshire Ltd
- Atco Pipelines
- Suncor Energy Inc
- Syncrude Canada Ltd.
- Access Pipeline
30 years of experience with hydrogeology; geochemistry; aquatic biology and fisheries; terrestrial biology and birds; soil science, land use, and vegetation; and stewardship, and conservation.

SECTORS

Oil and gas environmental sectors we serve:

- Upstream development and operations
- Midstream development and operations
- Pipeline design and operations
- Decommissioning and abandonment
- SAGD development and operations
- Oil sands development and operations

From concept to closure, we work with our clients to integrate projects with the biophysical environment. We work closely with our engineering teams to pioneer environmental management with the development of our cities, resources, and infrastructure.
ENVIRONMENTAL SERVICES

BIOPHYSICAL

We have a broad range of biophysical specialists across our Canadian offices. Our scientists use geographic information systems (GIS) to manage and report data. Our teams can deliver projects across Canada in mining, oil sands, oil and gas, infrastructure, and energy projects.

- Aquatic habitat and fisheries
- Wildlife and birds
- Soil, land use, and vegetation
- Water and water quality
- Habitat compensation
- Greenfield baseline assessments
- Impact and wetland assessments

ENVIRONMENTAL MANAGEMENT AND PERMITTING

Development, retrofitting, replacement, and expansion projects can be tricky in today’s regulatory environments. Let our team of industry and government trained specialists help guide your project through permit development, acquisition, environmental management plans, construction management, and environmental protection plans.

We can even help make sure your construction contractors are meeting their environmental contract requirements.

- Permitting plans and permit acquisition
- Environmental management plan
- Construction monitoring and management
- Environmental protection plans
- Regulatory approvals

OPERATIONS & CLOSURE

Our compliance and closure team have worked to develop cost effective strategies to keep clients in compliance with ever changing regulatory requirements and implement remediation and rehabilitation strategies across western and northern Canada in rangeland, alpine, boreal forest, and tundra environments. We understand the balance between client, community, safety, and environmental objectives for end land use.

- Phase I and phase II environmental site assessments
- Liability assessments and models
- Regulatory compliance monitoring and reporting
- Spill response
- Risk assessment
- Conceptual site models
- In-situ and ex-situ soil and groundwater remediation
- Re-vegetation plans
- Reclamation
ENVIRONMENTAL EXPERIENCE
Environmental Site Assessment
KCB has investigated potential environmental liabilities at more than 1000 oil and gas industry facilities. These facilities have included oil batteries, natural gas compressor stations, pipeline terminals and oil production sites.

Abandoned Gas Plant Remediation
KCB designed and implemented a groundwater monitoring program, conducted an intrusive soil and groundwater sampling program and developed a comprehensive remediation plan.

Environmental Liability Assessment
KCB acted as an expert witness and conducted environmental liability assessments on over 2100 oil and gas sites in Western Canada. KCB developed custom models to accurately reflect liability costs, based on the specific factors of each location.

Pipeline Leak of Condensate into Soil and Fractured Rock Impacting Groundwater in a Domestic Use Aquifer
KCB managed and executed a Multi-Phase Extraction (MPE) system for a pipeline break. The project remedial action plan, design and operation of a MPE system to mitigate the impact of a hydrocarbon plume originating 400 m from the pipeline break through a complex system of fractured rock.

Soil Monitoring and Management Programs for Sour Gas Plants
KCB designed soil monitoring proposals, implemented soil monitoring and management programs at sour gas plants in Alberta as part of ERCB directives.

Former Drilling Sump Assessment Program
We completed over 50 site assessments in the Mackenzie Delta. These included soil, surface water, permafrost and geophysical data collection.

ISR DEW Line Landfill Monitoring
KCB conducted geotechnical, soil and groundwater monitoring at seven remediated former DEW Line Stations in the western arctic.

Indian Oil & Gas Environmental Audit and Liability Assessment
We investigated and identified non-compliance issues with federal and provincial legislation, industry guidelines, and good operating practices.

Little Bow Reservoir, Alberta, Canada
Baseline studies and preparation of the Environmental Impact Assessment for the proposed increase in reservoir level for this major irrigation water supply dam.

Hardisty Bulk Petroleum Storage and Transfer Wetland Impact Assessment
KCB conducted an assessment to determine the area of impact construction activities had on a wetland. Based on a combination of air photo review and site reconnaissance it was determined that 1860 m² of wetland was impacted or destroyed.

Oil Emulsion Spill
KCB completed an assessment and remediation of an oil emulsion spill at a battery site. Spilled fluids flowed down a hill near the site and impacted a water body.

Environmental Management System Audits
KCB has conducted an Environmental Management System (EMS) audit of our client’s operations, with a focus on the Gas and Power Divisions. The audit report provides a detailed summary of findings, audit compliance scoring, and recommendations for improvements to the EMS system.
SERVICES

Railway Infrastructure
KCB has excelled in providing integrated geotechnical, civil and structural for major railways for over 60 years. Our team leaders bring more than 100 years of combined experience in design, construction and maintenance of the complete range of structures for the heavy-haul rail industry. Our projects include design, construction and maintenance of new track, tunnels, sidings, yards, trans-load facilities, bridges and track-protection structures.

Railway Grade and Slope Stabilization
KCB’s industry-leading team of geoscientists and hydrological engineers have been providing grade and slope stabilization services for major linear transportation infrastructure for more than 20 years. We specialize in managing the risks associated with railway ground hazards, including rock, debris and earth landslides, subsidence, surface and river erosion and seismic loading.

Pipeline Design and Integrity
KCB provides strong geotechnical and river engineering services, for both the design and operations/maintenance phases of a pipeline lifecycle. We’re often part of a pipeline routing team and provide risk-based geotechnical designs and integrity solutions for buoyancy control, ROW erosion control and geohazard mitigation. Our river design work spans the range of pipeline sizes and river complexities and we work closely with operations staff to develop cost-effective solutions.

Wellsite and Plant Access Roads
We bring a wealth of experience to the design and maintenance of access roads and bridges, to provide access to well and plant sites with cost-effective, environmentally-sensitive solutions. We respond quickly to provide installation of a variety of site access designs involving challenging subgrade conditions such as marshes, sand and wetlands to meet tight deadlines.

Transmission Powerlines
Our power team brings global design and construction experience to projects involving transmission systems up to 300 kV, hundreds of kilometres in length and all related facilities. Our projects span multiple industries including mining, large utility hydroelectric developments, marine facilities and heavy industrial ventures.
EXPERIENCE

Railway Rock Slope / Rock Shed Slide Protection
KCB designed an 80 m long rock shed in the Western Canadian Rocky Mountains. KCB’s modular rock shed design allows for construction under railway traffic. Our five phase methodology included:

i) characterisation of rock slope hazards using LiDAR and field mapping, ii) dynamic rock fall and stability analyses for conceptual design, iii) detailed structural design of rock shed, iv) preparing tender package and providing field services for installation of rockfall catchnet to protect work area, and v) QA / QC field services during construction.

Railway Grade and Slope Stabilization
KCB has an ongoing service agreement with a major Canadian railway company and have completed a variety of grade and slope stabilization projects including rock fall and rock slide assessments, embankment and slope stabilization, peat and weak soil subgrade assessments and stabilization. Work includes rock fall hazard assessments, rock shed designs, embankment and slope stabilizations, and track structure assessments.

Pembina River Crossing
KCB was retained to review pipeline burial depths at three crossings of the Pembina River in west-central Alberta. The primary objectives were to review the history of flooding in the crossing area; analyze the behaviour of the river with respect to bed scour, bank erosion and channel shift; and evaluate the need for repair and/or replacement of the crossings. The crossing location had experienced three major floods in the past 40 years with no significant impact on the pipeline.

Geohazard Management on Pipeline Rights of Way
KCB has undertaken a number of assessments of geohazards on or adjacent to the pipeline right of way. Typically the assessment involves site investigation and/or reconnaissance to determine the causes of the hazard, the potential impact on the pipeline and recommendations for mitigation. The more prevalent geohazards include: slope instability; drainage and/or erosion problems; buoyancy control failures. The results of geohazard assessment often are inputs to a pipeline integrity risk management program.

Gas Plant Access Road
We provided full detail design services for two washed out bridges on the access road a major gas plant in northeastern BC. Engineering services included critical geotechnical and hydrological components. At one site steel pipe foundation piles and precast concrete abutments were used, while cast-in-place concrete abutments on bedrock were required at the other site. Klohn Crippen Berger provided two replacement bridge designs, one 40-metre span and one 30-metre span, comprising steel plate girder superstructures with composite precast concrete decks.

Rural (Gravel) Road Upgrading - Design/Build
KCB undertook to design the upgrade of 4 km of rural road for through rolling terrain in northern British Columbia. The highway design included terrain mapping, realignment, drainage and geotechnical investigations.
Plant Facilities Foundations
For over 50 years KCB has provided design and construction management services for light to heavy industrial foundations. From shallow foundations for buildings and pipe racks to deep foundations such as driven pipe piles, rock-socketed caissons and concrete pile foundations for large plant site facilities, KCB has provided innovative and cost-effective solutions to the industry.

Well sites and Access Roads
We bring a wealth of experience to the design and maintenance of access roads and bridges, to provide access to well and plant sites with cost-effective, environmentally-sensitive solutions. We respond quickly to provide installation of a variety of site access designs involving challenging subgrade conditions such as marshes, sand and wetlands to meet tight deadlines.

Surface Water Management
KCB offers industry-leading design and construction inspection services for a wide range of surface water management solutions. Our project experience includes facilities surface water control structures such as perimeter ditches and water storage and treatment ponds, water-interception channels to keep plant sites dry and wetlands design and maintenance. We are also well-known for our numerical modelling capabilities including site water balance.

Pumps and Pipelines
Our mechanical team provides design services for water and slurry pipeline systems including all pumping requirements. Our mechanical services also include the design of boiler and steam distribution and industrial HVAC systems.

Granular Resource Management
Sourcing and transportation of granular materials represents a significant capital cost to projects. Our engineers are skilled in the identification and development of granular resources for remote projects. Our strength lies in the utilization of site materials that can be used which reduces the need to import granular materials.
EXPERIENCE

Wellsite Facilities Foundation Design
KCB provided geotechnical foundation engineering and inspection services during drilling of the bedrock to ensure that minimum effective pile lengths were installed. Material testing and quality control of the grout material being batched and placed by the piling contractor was provided during the pile grouting operation.

Cooling Tower Foundations
KCB served as the lead geotechnical engineer for the site characterization and foundation design of the pile foundation for a large cooling tower, which is part of a major expansion of the client’s processing facilities. KCB also provided on-site inspection services during installation of 270 steel driven piles and rock-socketed, bored, cast-in-place piles.

Facilities Drainage Planning
We provided a preliminary design and construction guidelines for implementation of drainage improvements. Recommendations for remediation of the roadway subgrade were also provided. Each civil earthwork task was identified with the proposed serviceability.

Gas Plant Surface Water Control
During the construction of the gas plant, an existing watercourse was interrupted and, once in operation, the plant site experienced water influx from the blocked watercourse.

KCB undertook a design of an interception channel to control this water, provided construction drawings and construction inspection services.

Battery / Compressor Site Surface Water Control
To manage the surface water in two locations within the compressor site, we undertook a site visit and designed a re-grading program for one location and a water retention pond and pump system to control water flows at the second location.

Brine Pond Design and Construction
KCB designed a temporary brine storage pond with a capacity of approximately 132,000 m³ of brine water which had an NaCl content of between 8%-12% and therefore could not be released into the environment.

Granular Resource Identification & Management
In all construction projects managed by KCB, we complete the identification of volumes and types of granular and other materials to meet construction requirements. These materials range from large soil types such as rip rap for ditch and channel construction to clay types for applications such as pond liners and core elements in water retention dams.
Site Water Management
We offer a broad range of water management skills including: site water balance, retention and treatment ponds, wet and dry ponds, underground storage facilities and hydraulic structures. We also provide construction management services.

Hydraulic Structures
KCB has the technical knowledge to design and construct diversion structures, diversion channels, spillways, sediment ponds, intake structures and decant systems.

Streamflow and Climate Monitoring
We are proficient at designing, installing, monitoring and maintaining streamflow monitoring and weather stations, including real-time communication systems in remote locations, to capture data needed to complete environmental studies and acquire regulatory approvals.

Hydrology and Hydrotechnical
KCB offers a full range of hydrology and hydrotechnical services including water balance modelling to evaluate available supply and storage needs. Hydrologic studies for assessing the potential for flooding and the need for flood mitigation works, environmental impacts and viability for hydropower development. Hydraulic and hydrodynamic modelling for designing river crossings, fish passage facilities, streambank stabilization measures and erosion protection works.

Wetlands
We can design and construct wetlands to mitigate water quality impacts and/or to enhance aquatic habitat.

Design and Construction of Waterbody Crossings
Baseline data collection, including bathymetric surveys and bed/bank material sampling. Hydrologic analysis, including flow regime, channel morphology, vertical and lateral scour. Support of HDD design. Support of regulatory permit applications. Field engineering and construction inspection.

Operation and Maintenance of River Crossings
Channel surveys and electromagnetic scoping of pipe. Design and construction of bank restoration/protection measures. Assessment of Depth of Cover and design and construction of mitigation measures.
EXPERIENCE

Gas Plant Surface Water Control
During the construction of the gas plant, an existing watercourse was interrupted and, once in operation, the plant site experienced water influx from the blocked watercourse. KCB undertook a design of an interception channel to control this water, provided construction drawings and construction inspection services.

Facilities Drainage Planning
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Compensation Wetland
The construction of a large tailings dam required diversion of a 5 km length of a local creek and the creation of compensatory stream and wetland habitat. The project team designed a new wetland and stream system integrated with the existing topography and vegetation thereby demonstrating a conscious change from the conventional “ditch and constructed wetlands pond” concept.

Water Balance Modelling
Three coal-fired generating plants and two coal mines are located in the watershed of Wabamun Lake. A water treatment plant was commissioned in 1996 to supply make-up to the lake to mitigate the effect of mining and power plant operations. We completed a comprehensive review and update of the water balance model which has been used to account for and forecast the effect of climatic conditions and operations on the lake level.

Streamflow Monitoring
At a number of industrial sites, KCB designed and implemented a streamflow monitoring program. Typically, streamflow data is collected from small ungauged creeks in the proposed area, using area-velocity meters. The streamflow data is then used in conjunction with rainfall data to determine the runoff characteristics of the watersheds, specifically the SCS Curve Number.

Pipeline Watercourse Crossings
KCB undertook hydraulic analyses of two oil pipelines cross Deep Valley Creek to assess the risk of exposure at the crossing location. Review of historical air photos showed that the channel had shifted substantially over the past 30 years and was experiencing channel migration. Deep Valley Creek is known to carry high flows during spring runoff and pipe exposure was a significant concern. KCB’s recommendations included three options to reduce the risk of exposure.
Baseline Characterization, Impact Assessment and Regulatory Approvals

Groundwater Source and Supply
Strategic advice on groundwater supply. Groundwater exploration, aquifer testing, and groundwater supply assessment. Complete supply wellfield design, installation, and commissioning. Mechanical and electrical design, instrumentation and SCADA connection, piping and storage design, and operations manuals. Groundwater monitoring system design to monitor system performance and meet regulatory compliance requirements.

Water and Waste Disposal
Strategic advice on injection well strategy and regulatory process. Field investigations to establish injection properties and determine injection rates, injection capacity, and to identify potentially limiting aquifer boundary effects. Injection and monitoring well designs, instrumentation and telemetry designs. Assessment of disposal water chemical compatibility with the groundwater and implications for well efficiencies.

Operational Performance and Compliance Monitoring
Groundwater monitoring designs to monitor system performance and confirm design expectations. Compliance groundwater monitoring program designs to meet regulatory approval. Designs for continuous remote data collection and telemetry systems. Groundwater compliance sampling, monitoring, and reporting. Database and data management design and hosting, and data QA / QC design.

Contamination Assessments and Remedial Designs
EXPERIENCE

Mine Groundwater Supply
The yield from previously-used wells of a large wetland had declined and did not meet the long-term water needs. Klohn Crippen Berger instrumental in the development of a new water supply for the Mine Complex, considering several supply options. After a geophysical survey and some pilot holes a production well installed in a high-yielding sand and gravel aquifer. It was found to be capable of providing both the design yield and the maximum permitted yield.

SAGD Project Groundwater Monitoring
The client proposed to convert their existing pilot plant to a SAGD demonstration project involving three phases. For each of the three phases, KCB provided the design of a groundwater monitoring plan, installed and decommissioned monitoring wells, conducted groundwater and surface water monitoring, soil remediation, and reported annual water use and groundwater quality.

Mine Pit Dewatering Design
The mine intercepts a major buried Pleistocene channel aquifer posing the risk of high groundwater inflows and pit instability. KCB developed a geologic model coupled with a numerical groundwater model to design a seepage control system and to optimize dewatering instrumentation placements. The seepage control system consisted of a combination of over 200 passive and pumping depressurization wells located in the main and associated secondary buried channels.

Well Field Design, Installation & Operation
As a part of a long-term seepage control system for a major tailings facility located on a large buried channel aquifer, KCB provided baseline data collection, pump testing, aquifer modelling, detailed well design and tender specifications. The system was designed to intercept seepage entering the Pleistocene channel from the tailings facility in order to protect adjacent natural water systems.

“Hell’s Half Acre” Site Assessment and Remediation Plan of an Historical Gas Facility
Hell’s Half Acre is the site of Dingman #1, the first oil well completed in the Province of Alberta. KCB conducted an assessment of the subsurface soil and groundwater contamination. KCB designed and managed monitoring, sampling and surveying ground and groundwater conditions as well as soil and vegetation. Site hydrogeology was characterized through information review, assessment of existing monitoring wells, electromagnetic and seismic refraction surveys, passive soil gas survey, physical aquifer testing, and groundwater sampling and analysis.
Down to Earth.
Up to the Challenge.