Dams engineering requires understanding and control of the enormous forces and potential energy of water. From foundation and seismic assessments through to geotechnical, hydrological, hydraulic, mechanical and structural design, projects demand in-depth skills and a coordinated, client-focussed approach.

**Identifying needs**

We recognise our clients’ need for solutions that harness in-depth knowledge with forward thinking to produce innovative, safe and cost-effective outcomes. We’ll work collaboratively with you to deliver results in line with these objectives.

**Services**

**Investigations, appraisals and studies** - We can work with you through the early phases of projects in the identification of project opportunities, site selection and optimisation, site investigations including geotechnical, hydrogeological and hydrological/hydrometeorological assessments, feasibility and option studies, environmental assessments and input for gaining statutory approvals.

**Design services** - We provide design services through all phases of a project regardless of size from concept through to detailed engineering. Our experience covers all disciplines including foundation design, dam design including sizing, zoning and stability, investigation and assessment of construction materials, modelling, analysis and design of hydraulic and structural components and design of mechanical components including gates and outlet works.

**Tender and construction phase services** - Development of robust tender documentation is critical to the successful delivery of your project. Our team brings their depth of experience to this task in the development of documentation to ensure the design intent is carried through to the finished product. We provide experienced construction engineers in both technical and project management through the construction phase to ensure the quality of the end result.

**Operational support** - Our people provide support throughout the operational life of dam assets in areas including asset management and valuations, condition assessments, dam safety and risk assessments, rehabilitation works including corrosion control and concrete repairs, sediment deposition management and seepage analysis and control solutions.

**Dam safety and risk assessment** - Ongoing maintenance of the safety of a dam and associated infrastructure is crucial in protecting communities and your assets. We’re experienced in all aspects of dam safety requirements including inspections, surveillance reviews, detailed safety reviews, development of dam safety documentation including dambreak analysis and emergency planning, dam safety training, and post-disaster inspection and assessment. A key strength of our team is the use of risk assessment for the review of the safety of both individual dams and dam portfolios.

**Owner’s engineer and review panels** - Successful project delivery starts with selecting the right solution and the right strategy. We offer experienced professionals in a range of technical and project management roles to provide guidance through all phases of a project including development of procurement strategies, technical peer review, due diligence assessments, construction phase services and certification services.

**Benefits**

Work with us and benefit from one of the largest dedicated dams teams across the globe. This team is backed by industry professionals in related fields including geotechnics, geology, hydrogeology, hydrology, river hydraulics, mechanical engineering, environmental sciences, materials technology and structures.

**What to expect**

You can expect surety of outcome through our depth of experience and breadth of services. We will work closely with you throughout the entire project life cycle to develop safe, innovative and cost-effective outcomes, maximising benefits for all stakeholders.
**Enlarged Cotter Dam, Canberra, Australia**

The Enlarged Cotter Dam (ECD) project included the design and construction of a new RCC dam immediately downstream of the existing Cotter Dam that increased the storage capacity of the existing reservoir from 4,000 ML to approximately 78,000 ML. The project included:

- 87 m high RCC gravity dam, with a crest length of 330 m and RCC volume 380,000 m³
- 60 m high dry intake tower incorporated into the upstream face of the dam
- Reinforced concrete stilling basin and outlet works at the toe of the dam
- Two zoned earth and rockfill embankment dams, 19 m and 23 m high, on the ridge forming the right abutment of the main dam to retain the enlarged storage.

As the design partner for the Bulk Water Alliance, GHD was responsible for the optimisation of preferred arrangement, detailed geotechnical and geological investigations, aggregate and RCC mix design investigations, borrow area investigations for the embankment saddle dams, design of the main dam, saddle dams, spillway and outlet works, computational fluid dynamic and scale physical modelling of the spillway and construction phase services including design advice. Construction was completed in 2013.

**Kangaroo Creek Dam Upgrade, Adelaide, South Australia, Australia**

The Kangaroo Creek Dam was completed in 1969, and is a concrete face rockfill dam with a side channel spillway. It was modified in 1983 by raising the crest level and lowering the full supply level to provide flood mitigation benefits. The dam is currently 63.5 m high with a crest length of 138 m.

GHD is designing upgrade works to ensure the dam meets modern standards and complies with relevant ANCOLD Guidelines by providing increased spillway capacity, improving resistance to extreme seismic loading events and increased drawdown capacity through the outlet works. The scope of the upgrade works includes raising the embankment height from 63.5 m to 69.4 m, extending the face slab, providing a full height downstream rockfill berm with transition zones, upgrading the vertical and perimetric joint waterstops, widening the spillway chute, extending the eastern ogee crest structure by 40.2 m, raising the spillway walls, anchoring the existing spillway ogee crest structure and modifying the outlet works to accommodate the embankment raise.

**Awoonga Dam Acceptable Flood Capacity Upgrade, Queensland, Australia**

GHD undertook a failure impact assessment of the saddle dam on the left abutment of Awoonga Dam which found that it was referable in its own right. This led to the assessment of options to upgrade the dam and spillway to meet the required level of AFC compliance. The proposed solution included a staged raising of the existing saddle dam, construction of a new saddle dam, raising of the main dam and opening an auxiliary spillway in a saddle remote from the dam. GHD was further engaged to undertake a concept design for the remedial works, geotechnical investigations, assessment of construction materials and scoping of approvals followed by engagement for the detailed design of the upgrade works, preparation of the technical specification, IFT and IFC drawings, preparation of applications for approvals (including vegetation management, EPBC, NCA etc) and ecological assessment of the site. Construction of the upgrade works was completed in early 2015. GHD provided design and site geotechnical advice throughout construction to assist GAWB in the delivery of the project.

**Baleh Hydroelectric Project, Prefeasibility and Feasibility Studies, Malaysia**

GHD was engaged by the Sarawak Electricity Board to undertake pre-feasibility and feasibility studies for the project. The services for which GHD was responsible were:

- Geotechnical investigations to assess foundation conditions and available construction materials
- Flood hydrological analysis including river gauging
- Sedimentation studies for the reservoir
- Dam type selection study to identify the optimal arrangement
- Design of the dam (which is a 220 m high concrete faced rockfill dam or RCC alternative with a stored volume of 26,000 GL)
- Diversion works design and optimisation using tunnel diameters from 8 m to 12 m from which the twin 12 m tunnels were selected with a coffer dam height of 45 m
- Design of the ungated concrete-lined spillway and downstream plunge pool to pass the PMF discharge of 28,900 m³/s
- Design of the 100 m high power intake structure and five 8 m dia power tunnels
Sg Kinta Dam, Malaysia

The Sg Kinta Dam project consisted of the design and construction of a new RCC dam on the Sungai Kinta with a reservoir storage volume of 29,900 ML. The project included:

- 90 m high RCC gravity dam, with a crest length of 980 m and RCC volume of approximately 900,000 m³
- 70 m high intake tower incorporated into the upstream face of the dam
- Ungated stepped spillway over the RCC dam section with a reinforced concrete roller bucket at the toe of the dam for energy dissipation.

The scope of GHD’s services on this project included feasibility study and concept design, review of hydrology, design of the dam and all associated structures (temporary site works, foundation excavation, spillway, diversion and intake works), quarry development, RCC mix design, tender phase assistance and construction supervision.

Eildon Dam Upgrade, Victoria, Australia

The upgrade of Eildon Dam included increasing the spillway capacity to pass extreme flood events and a safety upgrade to address concerns in regard to the existing embankment. Embankment upgrade works involved raising the embankment crest by about 4 m to a total height of about 85 m and the construction of a 1.2m high parapet wall. Spillway upgrade works involved the anchor installation to stabilize concrete structures, replacement of mechanical gate actuation system and modifications to an existing bridge over the spillway. The intake tower was also strengthened.

Ridgeway Dam Upgrade, Tasmania, Australia

Ridgeway Dam is a concrete arch water supply dam located near Hobart, Tasmania. The dam, constructed nearly 100 years ago, is currently undergoing upgrades to bring it in line with current ANCOLD Guidelines. GHD has been engaged to provide detailed investigation and design services for the proposed upgrade works, including geotechnical drilling and foundation mapping, installation of piezometers and other monitoring instrumentation, risk assessment workshops with stakeholder groups, finite element modelling of the dam, and detailed design and documentation of the upgrade.

Googong Dam Spillway Upgrade, Canberra, Australia

Googong Dam was completed in 1978 and forms one of the main water supply storage reservoirs for the Australian Capital Territory (ACT) and surrounding region. Successive flood events in 1978 and through the 1980s resulted in extensive erosion in the unlined section of the spillway chute, including a large erosion hole, up to 19 m deep and 25 m wide. Staged remedial works were undertaken in the 1980s to protect the eroded structure but the future integrity of the structure could not be guaranteed.

GHD Pty Ltd was engaged in 2006 to undertake a review of the historical performance and prediction of future performance of the structure. This included a review and assessment of previous work, the development and comparison of options and ultimately the detailed design of the preferred arrangement. A scale physical model was constructed as a validation tool during the detailed design phase. The construction of the remedial works was undertaken as a construction only package by the Bulk Water Alliance which included ACTEW Corporation, GHD, Abigroup and John Holland.

Lake Manchester Dam Upgrade, Queensland, Australia

Manchester Dam is a water supply dam for Brisbane. Construction of the 38 m high, 160 m long, extreme hazard mass concrete gravity dam was completed in 1916. Safety reviews identified several deficiencies, the most significant being spillway inadequacy and instability of the structure during relatively minor flood events. To prevent overtopping of the dam and stabilise the structure, the dam has been secured for the PMF event by means of post tensioned anchors, a 6 m raising of the non-overflow crest, and widening of the spillway with a new lined flip bucket chute.

The design for the dam stabilisation incorporated two rows of anchors (crest and toe). Crest anchors were 65 strands (250 kN per strand) at typically 3 m spacing. The total length of strand was 305 km and a crest spreader beam was required to distribute the anchor load. A new 50 m wide and 4 m high spillway crest structure was provided along with flip bucket and training walls. The spillway widening necessitated excavation and benching of the 60 m high slope above the spillway. The slopes were stabilised as required by rock anchors, shotcreting and drains.
Jindabyne Dam Spillway Upgrade, New South Wales, Australia

Jindabyne Dam is a 71 m high zoned earth and rockfill dam. GHD was engaged to undertake the concept and detailed design and tender documentation for an upgrade to allow for environmental releases and to increase the flood discharge capacity. GHD also provided design support during construction. The project included upgrading the existing spillway structure by retrofitting a concrete-lined chute, flip bucket and plunge pool, constructing a new 93.8 m wide auxiliary spillway controlled by 7.6 m high Hydroplus Fusegates and constructing a new 30 m high intake tower, tunnel and twin cone valves.

Kelalong Dam, Malaysia

Kelalong dam is a water supply dam for the Bintulu District in Sarawak and is located about 20 km northeast of Bintulu. The project involved the pre-feasibility and feasibility study for the dam, including yield analysis and hydrological studies, followed by detailed design and provision of assistance during the tender and construction phases. Key features of the project include:

- Left bank cut-off trench extending 410 m beyond the dam through two low saddles
- Main zoned earthfill dam embankment (30 m maximum height and 460 m crest length)
- Outlet works consisting of a dry tower to release up to 292 ML/day
- Right bank saddle dam embankment (19 m maximum height and 330 m crest length)
- Total reservoir storage capacity of 33,700 ML
- Ungated concrete-lined spillway chute and stilling basin

Ross River Dam Upgrade, Queensland, Australia

The Ross River Dam was completed in the 1970s as a combined water supply and flood retention project. The dam was 24 m high and 7.7 km long with a combined central core rockfill section transitioning to a zoned earthfill embankment and free overflow spillway weir section with downstream energy dissipator. The dam was upgraded using a risk-based design justification by the provision of downstream filters, raising the embankment crest by 0.7 m and installation of three 3.6 m high radial gates for increasing the storage capacity and improving the flood mitigation.

Upgrade of Wellington Dam, Western Australia, Australia

Wellington Dam is a 34 m high concrete gravity dam on the Collie River south of Perth impounding a storage of 180 GL. GHD was appointed by Water Corporation of Western Australia to carry out the detailed design, then to provide construction advice for risk reducing remedial works. The design included approximately 40 anchors of up to 91 strands to counter uplift pressures on the dam. The remedial works also included a new bridge for improved access, new downstream toe drainage and new access through the dam between galleries. Significant concrete cutting tasks were required and architectural finishes were designed for the bridge and public access zones.

Safety Upgrade of Quipolly Dam, New South Wales, Australia

GHD was engaged in 2009 to undertake concept and detailed design for the safety upgrade of Quipolly Dam on behalf of the Liverpool Plains Shire Council. The appointment included hydrology review, geotechnical investigations, upgrade to improve spillway capacity and reduce the risk of piping through the embankment and along the spillway retaining wall, OHS upgrade of intake tower top platform and replacement of intake tower access bridge piers. The client also required an increase in the storage capacity. Construction was successfully completed in 2013.

Little Para Dam Upgrade, Adelaide, South Australia, Australia

GHD undertook a Safety Review incorporating a concept design of upgrade works. GHD was then commissioned to undertake a detailed design in 2007 to increase spillway capacity and improve stability of the existing spillway structure.

The upgrade works included raising the existing dam crest parapet wall by 1 m, excavation of a 360 m long and 52 m wide auxiliary spillway channel, construction of a 12 m wide concrete overflow sill to the auxiliary spillway with 6.5 m high Hydroplus Fusegates and a grout curtain beneath the overflow sill connected to the existing grout curtain across the upstream end of the primary spillway.
Dam Safety Surveillance and Inspection Services, Victoria, Australia
GHD has undertaken dam safety surveillance and inspection services, including intermediate and comprehensive dam safety inspections of dams ranging in height from 5 m to 58 m, for the following dam owners in Victoria:

- Barwon Water: 28 dams
- Central Highlands Water: 13 dams
- Coliban Water: 7 dams
- Gippsland Water: 4 dams
- Goulburn Valley Water: 13 dams
- North East Water: 16 dams
- SA Water: 2 dams
- Wannon Water: 28 dams
- Western Water: 18 dams
- AGL Energy: 12 dams
- Loy Yang Power: 4 dams

South Para Dam Upgrade, Adelaide, South Australia, Australia
GHD undertook a detailed risk assessment and staged safety review in 2005. GHD then undertook the subsequent detailed design in 2009 to address inadequate flood capacity and risk of piping failure of the embankment.

The upgrade works included filter protection to the embankment above the existing top berm level, raising the embankment crest level by 3 m including a 1 m high reinforced concrete parapet wall, 1.5 m mass raising with grouted foundation anchors to the existing ogee spillway crest.

William Hovell Dam Upgrade, Victoria, Australia
GHD undertook the detailed design for interim risk reduction upgrade works. The project included computational fluid dynamic modelling of the spillway structure, spillway erosion risk assessment, design of the main embankment filter extension, crest raising, filters, rockfill shoulder and concrete parapet wall, design of the secondary embankment raising including filter extension, earthfill and filter crest raising and upstream beaching, design of grouted spillway crest anchors, design of spillway chute wall raising, strengthening and stabilising including anchors and construction phase design services.

Cairn Curran Dam Upgrade, Victoria, Australia
GHD was engaged in 2003 to develop an interim risk based upgrade package. The project included detailed geotechnical investigations of the main and secondary embankments, 3-D finite element analysis of the spillway piers and radial gate trunnion beam, spillway chute erosion protection design, 3-D post liquefaction stability assessment of main embankment, filter buttresses design, main embankment crest raising with a combination of earthfill and concrete parapet wall, outlet valve upgrades, minor pipework refurbishment and construction phase design support.

Mt Bold Dam Safety Review, South Australia, Australia
GHD was commissioned to undertake a comprehensive safety review of Mt Bold Dam. Part of this included a 3D nonlinear time-history analysis to capture the nonlinear behavior of an arch-gravity dam and to assess the behavior of the unique modifications which have been made since its original construction.

The structural assessment used the finite element program DIANA to model the dam wall and foundations. Varying types of interface elements explicitly modelled the 18 contraction joints between the monoliths, the dam-foundation contact, and the contact between the original dam and the dam raising which generally were allowed to open, close and slide thereby redistributing the demand and presenting the behavior of the dam more accurately. The dam wall was assessed in terms of stress and stability, and the reinforced concrete elements of the raising were explicitly assessed for bending, shear and axial tension/compression.
Portfolio risk assessment review for State Water Dams, New South Wales, Australia

A review of the PRA was undertaken for 18 major dams comprising concrete arch, concrete slab and buttress, concrete gravity, concrete face rockfill, earthfill, and clay core rockfill types of dams up to 114 m height, with 10 classified as Extreme Consequence Category.

The study included estimation of the failure probabilities (including failure modes analysis, event trees analysis, and piping risk assessment using the “Piping Toolbox”), risk workshops, risk calculations, risk evaluation and preparation of the Portfolio Risk Assessment Report.

Portfolio risk assessment review for Coliban Water Dams, Victoria, Australia

A review of the PRA was undertaken for 13 major dams comprising one multiple arch buttress dams and 12 earthen dams.

The study included the estimation of the failure probabilities (including failure modes analysis, event trees analysis, and piping risk assessment using the “Piping Toolbox”), risk workshops, risk calculations, risk evaluation, prioritisation of risk reduction works, and preparation of the Portfolio risk assessment report.

Risk assessments Water Corporations, Victoria, Australia

GHD is providing dam safety services to various Water Corporations in Victoria, including Wannon Water, Barwon Water, Western Water, Goulburn Valley Water and North East Water, and previously for Central Highlands Water and Coliban Water. The portfolios of dams generally include water supply service basins, water treatment lagoons and winter storages.

As part of the services GHD is undertaking (and reviewing yearly) the risk assessments for the High and Extreme consequence category dams. The risk assessments include event trees analysis, with internal erosion assessed using the “Piping Toolbox”.

Logue Brook Dam Upgrade Works, Western Australia, Australia

Harvey Water engaged GHD to perform the project management, detailed design, and construction supervision of the Logue Brook Dam Outlet Works Upgrade. The scope included modification of the outlet works to provide a connection to the Harvey Water Pipeline. This included upgrading the facilities in the intake tower to enable closure of the upstream end of the outlet pipe in the intake tower, demolition and reconstruction of pipework in the valve house and connection to the new Harvey Water Pipeline, and installation of SCADA controls and telemetry.

Samson Brook Dam Remedial Works, Western Australia, Australia

GHD carried out engineering and detailed design and provided construction support during implementation works to reduce risk to life associated with a potential failure of Samson Brook Dam. Stage 1 of the remedial works was an upgrade of the outlet works, including installation of new outlet conduits and reconstructing the intake. Stage 2 focused on piping risk reduction measures by replacing the downstream rockfill shoulder and installing filters on the downstream face and around the outlet conduit. Stage 2 also included construction of outlet works infrastructure downstream of the dam.

Kununurra Diversion Dam (KDD), Western Australia, Australia

The KDD is one of the key facilities of the Ord Irrigation Project consisting of a central concrete spillway with 20 radial gates, flanked by earthfill embankments. In 2012, GHD completed a risk assessment which identified potential failure of the trunnions supporting the radial gates and abutment piping as the two main risks at the dam. GHD completed the detailed design to replace the function of the trunnions in the event of a structural bar failure. GHD also completed a detailed risk assessment to assess the risks associated with piping, stability and liquefaction at the earthfill abutments of the dam.

Junction Dam Seismic Analysis, Victoria, Australia

GHD was engaged to perform a safety review on Junction Dam, a reinforced concrete slab and buttress type dam (Ambursen) which is part of the Kiewa Hydro Electric Scheme. The dam wall comprises 19 buttresses spaced at 6.1 m along its 116 m crest and incorporates a 36.6 m wide spillway near the left abutment. Its maximum height is 26 m. The structural assessment included a seismic linear elastic response spectrum analysis for the Operating Base Earthquake (OBE) and Maximum Design Earthquake (MDE) incorporating the subgrade reaction at the base of the dam.

www.ghd.com
Kwinana Water Recycling Plant (KWRP) Upgrade, Western Australia, Australia

The Water Corporation engaged GHD to undertake the design, superintend the construction contracts and provide technical construction support for the reconstruction of the KWRP Northern and Southern Ponds. This work was required due to failures in the existing liners. The reconstruction works scope included earthworks on the existing pond walls to improve their foundation and to achieve more stable slopes, installation of a double liner system (HDPE), upgrading the inlet and outlet pipework and installing a straight diffuser pipe to address vortex formation at the outlet and reduce liner damage at the inlet.

Mundaring Weir High Level Outlet Upgrade, Western Australia, Australia

GHD was engaged by the Water Corporation to design the High Level Outlet upgrade for the iconic Mundaring Weir. The upgrade was part of a suite of upgrade projects for the weir to improve the capacity reliability and quality of the water delivered to the Goldfields and Agricultural Water Supply. The works included a condition assessment of the existing infrastructure, hydraulic modelling, and design of the refurbishment or replacement of infrastructure. Upgraded site and dam crest access and security solutions for new and existing structures were also included in the scope of works.

Milford Dam, Tasmania, Australia

GHD provided detailed design and construction phase services for the construction of a 770m long, 24m high zoned earthen embankment dam as part of Tasmanian Irrigation’s Lower South Esk Irrigation Scheme. The project, performed under a Design & Construct contract, required close liaison with the construction contractor and the client, Tasmanian Irrigation. Construction of the dam was completed in 2013.

Meander Dam, Tasmania, Australia

GHD were engaged to provide investigation, design, tender phase and construction phase services for the Meander Dam located in the Meander Valley, for Hydro Tasmania. Completed in 2007, the 43,000 ML dam was constructed from Roller Compacted Concrete requiring an on-site batch plant. GHD additionally provided quality assurance testing for batch plant throughout the construction period.

Didipio Tailings Storage Facility, Luzon, Philippines

Since 2011, GHD has been providing design and construction phase services for Oceana Gold’s Didipio Operation located in central Luzon, Philippines. This has involved the staged design and construction of their Tailings Storage Facility (TSF) and integration of a flow-through spillway under the mine’s waste rock dump. Development of the TSF required GHD to work closely with the mines scheduling to incorporate waste rock production into the embankment.

Sturt River Dam Safety Review, South Australia, Australia

As part of a staged Safety Review, GHD was engaged to undertake a 3D finite element response spectrum seismic analysis of Sturt River Dam. The dam wall is a 40 m high double curvature arch dam consisting of 7 monoliths and 2 thrust blocks on either side. The dam was modelled using the program Strand7, and included modelling of the construction staging in order to more accurately determine the stresses in the dam. Normal, flood and earthquake cases were investigated to establish any areas of overstressing or instability of the monoliths.

Cardinia Reservoir, Victoria, Australia

In 2010 GHD undertook for Melbourne Water a review of the spillway hydrology and a dam break analysis to provide updated inundation mapping using outputs from a two dimensional model for the sunny day and wet day failure cases. From the updated inundation extents an estimate of the PAR and PLL was undertaken using Graham (1999). A severity of damage and loss assessment was undertaken and from this analysis a Consequence Category was assigned to each of the reservoirs.

To make contact with a Dams specialist in your region, visit

www.ghd.com/global/services/dams