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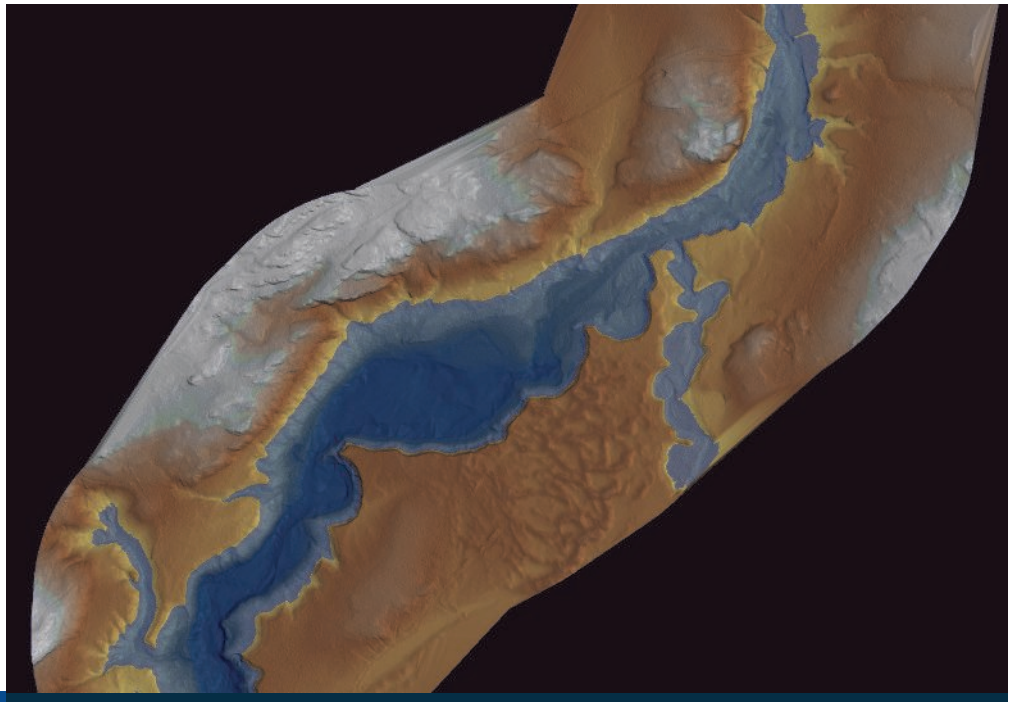
Water Resources PROFILE

Our team is able to offer an extensive skill set to provide sophisticated design, engineering, scientific, and geospatial solutions to a wide range of resource planning and management needs. Our integrated multi-disciplinary approach to problem-solving and our commitment to quality and cost-control are the basis of our success as a consulting company. We take pride in serving clients in the areas of energy, transportation, environment, natural resources, and social sciences.

We provide our services to a diverse group of clients within a variety of business sectors, public and private, who all share common goals and face similar challenges. Acknowledging the triple bottom line means they must improve the cost efficiency of their operations while minimizing their impacts on the environment and balancing social concerns.



SERVICE AREAS

1. **Strategic Planning and Consulting**
   - Requirements analysis
   - Technical reviews
   - Planning support
2. **Mapping and Visualization**
   - Water/land resources mapping
   - 2D/3D/4D maps and multimedia
   - LiDAR/Satellite and aerial imagery
3. **Dam Safety**
   - Inundation modeling
   - Consequence analysis - loss of life, social-economic, and environmental
4. **Siting Assessment**
   - Small hydro development
   - Environmental Assessment support
5. **Water Modeling and Forecasting**
   - Snow hydrology
   - Lake/reservoir evaporation
   - Hydrometeorology/climate analysis
   - Hydrodynamic modeling
6. **Applications Development**
   - Adaptive Water Management Systems
   - Software design and implementation
7. **Training and Education**

SUPPORTING YOUR WATER RESOURCES NEEDS

For the past 13 years, 4DM has been helping its clients in the water resources sector meet the challenges they face. Water is essential natural resource where managing water involves considerable effort, as multiple competing factors must be well understood and properly balanced.

Water managers must continuously contend with various issues that can impact the quality and availability of water, ranging from natural events to human activity while taking environmental requirements, policy directions, and other factors into consideration that are often beyond their control.

4DM offers science and engineering services that can help your company or organization deal with your most pressing water-related challenges in cost-effective ways. Whether a small conservation authority or a large corporation, our highly skilled multi-disciplinary team is able to handle any of your water assessment needs. Our team, which consists of experts in hydrology, hydraulics, water quality, remote sensing, and geomatics, can provide you with the answers you need.

We follow very rigorous quality management protocols that safeguard the integrity of your data and information. We also take pride in our formal project management processes which help us maximize our ability to deliver on your requirements.

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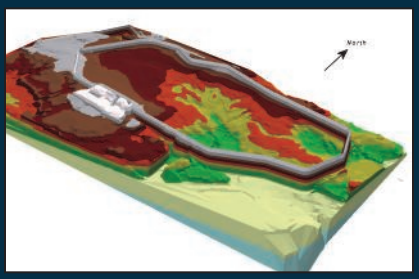
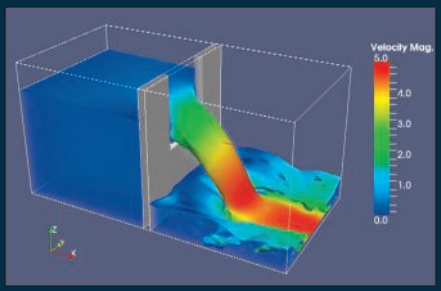
Dam Safety Inundation Modeling and Consequence Analysis

4DM has significant experience conducting hydrotechnical assessments (inflow modeling, dam breach modeling, flood-wave routing), production of inundation mapping for emergency preparedness and dam failure consequence analysis in support of dam safety assessments for large, complex systems as well as for smaller dams. Our dedicated engineers and GIS specialists customize their efforts to meet your specific modeling, mapping, interpretation, and reporting needs, whether you require high-impact visualization products for communicating technical results to your stakeholders, need technical documents to meet your legal compliance requirements, or would like to have a presentation expertly crafted and professionally delivered to your corporate team.

Geospatial Analysis & Modeling for Siting and Environmental Mapping

With 10 years of experience in the field of GIS and remote sensing, we have total confidence in our ability to serve all of your geospatial analysis and mapping needs. We have conducted renewable energy siting, environmental sensitivity mapping, processed topographic data, performed complex statistical and 2D/3D/4D geomatic analyses, and produced bathymetric profiles for numerous clients, including hydro-utilities, conservation authorities, municipal clients, environmental agencies, mining companies, nuclear safety agencies, and emergency preparedness organizations. Our team, composed of GIS experts, engineers and scientists are advanced users of the latest geomatics tools and ready to tackle your projects, no matter how large or small, complex or simple.



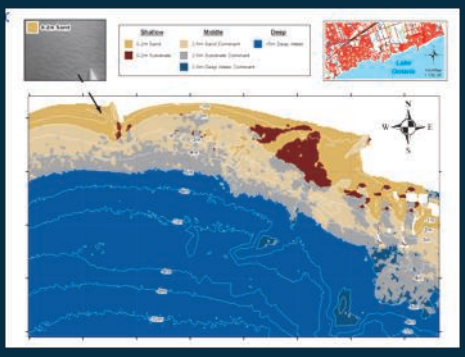


Hydrodynamic Modeling for Water Levels and Flows

Our staff would be pleased to help you carry out your water projects. Conducting flow regime and eco-hydraulic assessments, computing water budgets, understanding erosion and sediment transport processes, writing technical reviews related to water modeling, and developing advanced decision support systems are all areas in which we have demonstrated capabilities and expertise that can be readily deployed to serve your specific needs. Our team has experience with a variety of numerical models, including SWAT, HEC-RAS, HEC-HMS, MIKE 11/21/Flood, TELEMAC 2D/3D, and OpenFOAM (CFD). Combined with our extensive expertise in geomatics, and our interpretive skills, our modeling capabilities allow us to provide you with comprehensive answers to your water-related questions.

Visualization for Public Consultation

Visualization not only provides a powerful means to analyze and interpret data but can also be very effective at conveying the results of scientific investigations and numerical simulations, as well as for providing meaning to decision-makers and stakeholders. 4DM can develop and produce strong visualization products that are tailored to your specific needs, ranging from simple graphs to information-rich static or animated 3D renderings of complex geospatial datasets. Whether you require interpretive products in support of your water resources management decision-making activities, need data exploration tools to facilitate corporate level planning processes, or are looking for visualization products that are easily interpreted by a non-technical audience, 4DM is here to help you.



Remote Sensing Applications for Water/Land Characterization

Accurate information of your watershed can present major challenges when you lack suitable geospatial datasets and areas of interest are difficult to reach. In particular, the quality of your topographic and land cover information can impose significant limits on the quality of your hydrological and hydraulic modeling results. 4DM can provide you with end-to-end management and analysis of your aerial data and satellite collection campaigns, working with orthophotography, LiDAR and, multispectral and hyperspectral data from planning to collection to analysis. We pay close attention to your technical requirements and perform multiple detailed quality checks throughout the data gathering process.

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Sample Projects

G. Ross Lord Dam Safety Review

Toronto and Region Conservation Authority

Toronto and Region Conservation (TRCA) owns and operates several dams and channels across the Greater Toronto Area to mitigate flooding in vulnerable areas following the 1954 Hurricane Hazel event. 4DM and Sanchez Engineering were contracted to conduct a full Dam Safety Review of one of these structures, the G. Ross Lord Dam as required by the Provincial Dam Safety Guidelines. 4DM was tasked with conducting the hydrotechnical component which included the hydrotechnical modeling (Sunny-Day and Flood-Induced failures), development of inundation maps and performing a detailed consequence analysis to confirm the Hazard Potential Classification of the

Little Jackfish River Hydro Development Project

Ontario Power Generation (SENES Consultants Limited)

Little Jackfish River, located in northwestern Ontario draining into Lake Nipigon, is a viable potential location for establishing a generating station under the provincial energy production mandate. OPG currently operates a control dam at the top of Little Jackfish River and has conducted studies in the past to assess the viability of a potential hydropower generating station. 4DM has provided geospatial and technical modeling support that included a hydrological assessment, viewshed analysis, erosion susceptibility mapping from LiDAR data, climate analysis, and ongoing mapping, as well as the generation of advanced visualization products for corporate use and to disseminate information to public stakeholders (www.littlejackfish.com).

Provision of Expert Advisory Service — Taltson Hydroelectric Expansion Project

Mackenzie Valley Environmental Impact Review Board (MVEIRB) (SENES Consultants Limited)

Deze Energy Corporation in the Northwest Territories proposed to expand an existing hydroelectric facility to enable electrical transmission to diamond mines in the far North. MVEIRB is responsible for reviewing the developer's environmental impact assessment and recommend whether the project should proceed. 4DM provided expert knowledge to MVEIRB and support in the form of interpretation and analysis of the proponent's environmental assessment report, particularly in the areas of hydrology, erosion and climate change. Work involved review of submission reports for technical review, and the 4DM staff took part in interactive technical sessions held with the proponent, MVEIRB, various governmental agencies, and First Nations organizations.

LiDAR Hydro-Enforcement and Property Rights Mapping

Ontario Power Generation

The focus of this work was the generation of high quality products, such as digital elevation models (DEM) and contours, to satisfy OPG's hydrological modeling and dam construction requirements by targeting 19 river systems (>14,000 sq. km of data) for this study. Raw LiDAR elevation datasets were processed to correct the key issues causing inconsistencies in the rendering of stream and river water elevation profiles. In order to develop a more accurate representation of the topology of the study area, the river banks and smaller streams were modeled using breaklines. The breaklines were then combined with the LiDAR ground points to generate triangulated irregular networks (TINs) which were then converted to a DEM. Formal procedures to assess the quality of the work were implemented for each stage of the project. Several additional post-processing steps, including the use of orthophotos for alignment purposes and inspection of the final product using 3D visualization, were carried out to identify any problems. The data was then used to support property rights mapping including water power leases, licenses of occupation, flood easements and ownership. It is also being used for hydrodynamic modeling and asset mapping.

Recommendations For Updating Guidelines For Mitigating The Impingement And Entrainment Of Fish At Fresh Water Intakes In Fisheries And Oceans Canada Central And Arctic Region

Fisheries and Oceans Canada (SENES Consultants Limited)

Fisheries and Oceans Canada (DFO) current guideline documents for fish protection at water intakes provide detailed guidance on the design of screens for small intakes (≤ 0.125 m^3/s) and basic guidance for larger intakes. DFO awarded a contract to SENES and 4DM for the development of a detailed guidance for larger intakes and mitigation strategies to avoid fish losses through impingement and entrainment. 4DM provided detailed input regarding flow requirements, including recommendations on hydrological analysis and numerical hydraulic modeling approaches, based on a detailed review and interpretation of the existing literature. A review and discussion of guidelines for intake screen designs was also produced.

Impact of Wind, Temperature, and Other Environmental Factors on Reservoir Evaporation Losses

Centre for Energy Advancement through Technological Innovation (CEATI International)

CEATI's Water Management Interest Group (WMIG) commissioned an assessment of the current state of knowledge with respect to technologies and methodologies that could potentially be used by the hydropower industry to obtain more reliable estimates of evaporative water losses from lakes and reservoirs. The project consisted of a comprehensive search and assessment of available relevant literature and an online survey, aimed at water resource managers and scientists, to complement the results of the literature search. This research work culminated in a detailed report which describes the key attributes, strengths, and limitations of existing methodologies and specifies research areas or directions that would provide further gains in theoretical and practical knowledge that could ultimately benefit WMIG members in their pursuit of improved solutions for water balance estimates.

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Mapping Impervious and Pervious Layers Flood Analysis

City of Surrey

The City of Surrey selected hyperspectral airborne imagery as an option to support land surface classification for municipal planning and support activities as well as land surface change detection across the city. Hyperspectral imagery was used to apply a semi–automated information extraction algorithm for boulevard and tree classification within city parks, road allowances, and easements. The imagery will also be used for general vegetation classification and to map impervious and pervious areas in support of hydrological modeling for surface run-off and sanitary inflow and infiltration analysis. 4DM used a combination of existing vector mapping data, orthoimagery, and processed LiDAR digital surface model with CASI hyperspectral data to perform land classification analysis.

Study on Erosion Mitigating Impacts Related to Adam Creek

Mattagami Extensions Coordinating Committee (MECC)

The Lower Mattagami River Complex (LMRC) consists of four hydroelectric stations that provide base and peak electricity production for the Ontario electrical grid. Due to insufficient storage of the main headpond and limited capacity of the downstream generating stations, meltwater flows (freshets) are diverted through Adam Creek. Unfortunately, diverting high peak volumes and velocity flows through Adam Creek has reshaped its physiography, including the Mattagami River confluence, as a result of severe erosion. 4DM and SENES were contracted by the Mattagami Extensions Coordinating Committee (MECC) to assess potential mitigation measures that could reduce the impacts to the downstream environment associated with releasing high flows into Adam Creek.

Saskatchewan Multiple Dam Classification And Inundation Mapping

Agriculture and Agri-Food Canada (AAFC)

The Water Infrastructure Division (WID) of Agriculture and Agri-Food Canada (AAFC) operates a diverse portfolio of water infrastructure in southwestern Saskatchewan, including thirty three water storage projects. In conformity with the principles and practices of the Canadian Dam Association (CDA) Dam Safety Guidelines (2007), AAFC commissioned a detailed consequence assessment and classification of five dams located in Southern Saskatchewan. 4DM, in partnership with HDR Inc., utilized high-resolution LiDAR data and orthophotography to develop dam breach and floodwave models to determine the resulting flood inundation for Sunny-Day and Flood-Induced failure scenarios. A detailed analysis of the dam failure consequences was performed examining Life Safety, Economic Impacts, Environmental Consequences, and Cultural Losses to establish the dam hazard classification. Inundation maps for use in for Emergency Preparedness Planning and Response activities were prepared as well.

Renewable Energy Siting and Screening Analysis

EDF Energies Nouvelles (EN) Canada

4DM was contracted to identify and map lands suitable for renewable development in as a part of Ontario's FIT program taking into account socio-economic considerations, environmental, and legislative constraints, and site limitations. Site specific analysis was then conducted to determine property parcels suitable for the development. Key deliverables provided included a siting maps, priority properties for development, and a geospatial database containing all spatial data developed during the project.

Environmental Sensitivity Mapping and Contaminant Geodatabase Development

Ontario Power Generation (OPG)

For many years OPG has conducted environmental studies with respect to fisheries, plant species, biodiversity, and contaminated lands at or near operating stations, in support of monitoring and compliance activities. The results of these studies were disperse and not in a geospatial format needed for visualization and environmental analysis. 4DM interpreted, digitized, modeled, and documented the relevant environmental features into a geodatabase for 65 active generating stations. Information was then assembled to into standard template to represent environmental sensitive areas and contaminant locations, included into OPG's Spill Prevention and Contingency Plan (SPCP).

Adaptive Water Management System

Ontario Power Generation (OPG)

In Ontario, dam owners are required to develop water management plans with other stakeholders to address requirements with water levels and flows to balance the needs of water users with community and environmental considerations. 4DM developed web-based decision support systems for OPG to meet water management requirements. The system uses a spiral model approach to evolve the understanding of the watersheds they operate hydro facilities within. Compliance reports can be generated, public communications tracked, and real-time gauging visualized using web-mapping. Numerical Weather Prediction data is also incorporated to anticipate changing conditions in the watershed.

Remote Sensing to Map Algae in Lake Ontario

Ontario Power Generation and Entergy Inc.

The large growths of algae around the water intakes present significant challenges to operators of nuclear power stations. 4DM conducted a study for Entergy Inc. and Ontario Power Generation, to demonstrate how remote sensing technology could be applied to the estimation of algae concentrations and movement in the vicinity of three nuclear plants located along the shores of Lake Ontario. 4DM assessed the performance of both high resolution (QuickBird and IKONOS) and low resolution (MODIS and MERIS) satellite imagery by satellite tasking, data processing, integration with SHOALS LiDAR bathymetry data, and spectral analysis, where the project team was able to accurately map the spatial distribution and total biomass of algae near all three nuclear stations.

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