Halifax Water Information Technology Strategic Plan

Prepared for: Halifax Water
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Executive Summary

Introduction

Halifax Water requested proposals for consulting and planning services to develop an IT strategic plan which aligns with the organization's strategic and tactical goals. Halifax Water wanted to ensure that IT investments meet the future needs of the business, supporting the efficient and safe delivery of world class end-to-end service in all its lines of business (Water, Wastewater, Stormwater).

Halifax Water last developed an IT strategic plan in 2001. Changes in technology, the organization and customer needs have reinforced the desire to review the current IT direction and ensure it is aligned with the organization's strategic and tactical plans.

Objectives

The objectives of the IT Strategic Plan were to;

- Review the existing strategic and business plans of the organization, as well as the general operations and use of technology in place today.
- Create an IT Strategic Plan that aligns with the above that will guide Halifax Water in governing, planning, procuring, implementing, operating and managing current and future technology investments and resources over the next five years or more.
- Provide Halifax Water with both the roadmap for technology investments, as well as the structured program approach for implementing the roadmap.

Halifax Water selected Mariner Innovations to develop an IT Strategic Plan. Mariner leveraged a proven methodology and a comprehensive, structured approach to Current Assessment, Strategic Visioning, Architecture, and Five Year Investment Plan.

Discovery and Assessment

Mariner undertook a series of consultations with key stakeholders throughout the organization. Mariner also collected and reviewed a variety of documentation and other information necessary to develop a complete understanding of the technical and associated business environments.

Highlights of the Current State Assessment:

- Halifax Water has a clearly defined value proposition;
- The organizational structure is aligned with key business functions and processes;
- For the most part, systems and assets are currently meeting basic business needs;
- Investments will be required to replace or evolve some assets (e.g. CRM) in order to better meet future needs;
- One consistent, observable area of significant elevated risk is in the area of disaster recovery planning and infrastructure;
- Data centre facilities (the physical space which house computing and networking infrastructure) represent a moderately elevated level of risk; and,

- Common IT functions (services) are provided by different departments within Halifax Water and by Third Party Providers such as HRM IT and the Province of NS/IBM. Standardization, and appropriate governance is required to effectively manage multiple operating models.

As part of Discovery and Assessment, Mariner undertook research and a review of leading trends associated with the utility sector and, in particular, public water utilities. Understanding these trends in the context of Halifax Water helped identify opportunities and informed the strategic vision.

Mariner identified and examined trends in the areas of:

- Cyber Security;
- Advanced Metering Infrastructure (AMI);
- Cloud Computing;
- Business Intelligence and Analytics;
- Customer Portal;
- Asset Management;
- Field Data Collection;
- Geographic Information Systems (GIS); and,
- Mobile Computing.

Of particular note, many water utilities have recognized the value of AMI and are making investments in this capability. Halifax Water is leading in this regard and has a major program already underway to implement AMI across their customer base. Halifax Water has also had a GIS implemented for a number of years and continues to leverage and evolve this capability. Finally, Halifax Water has implemented an industry leading CMMS (Computerized Maintenance Management System) – CityWorks.

Strategic Visioning

Halifax Water's IT Strategic Vision was established by analyzing internal data collected, interviews, industry trends, business drivers and the current state of IT within the organization. In addition, Mariner facilitated a series of collaborative workshops to establish and gain consensus for a clear vision for how Halifax Water wants to position and utilize information technology in the context of its business and utility operations.

Halifax Water's Strategic Vision for IT is summarized by the following statement:

> *Halifax Water wishes to be an innovative user of established technology to enhance their customers' experience, improve performance, manage the inherent risk of being a public essential operation and have engaged employees with the tools to do their work effectively, all while maintaining fiscal responsibility.*

Halifax Water wants to be innovative in its use of information technology however such technology should be stable and well-established, so as to mitigate the risk of employing unproven technologies in providing critical infrastructure and services. The Strategic Vision emphasizes the importance of key goals in the areas of customer experience, maintaining public trust, and fiscal responsibility.

Strategic Themes

Six key themes will characterize the focus for the next five years of IT investment:

1. Customer Experience – Providing customers with the ability to access most services using the online site or smartphone. This includes being able to find out the status of service requests.
2. Information Integration with Location - Having all necessary data linked together and also tracked to location. Having the ability to access information and trends through a geographic lens.
3. Analytics Driven Decision Making - Able to model using all customer usage data, environmental data, and infrastructure data across the Water, Wastewater and Stormwater systems. Able to tie financial, operational, and system data together into business intelligence.
4. Managed Knowledge and Workflow - Key content is captured and stored logically and easily accessible by those that require it. Key processes and policies are guided and monitored for employee effectiveness and regulatory compliance.
5. Enable Employees Anywhere - Employees can access, capture and update the information they need to effectively do their job and support others, wherever they may be working.
6. Secure IT Foundation - Infrastructure is resilient, cost effective, well supported, and recoverable within clearly defined requirements. The IT function (Planning, Delivery and Operations) is effectively managed.

IT Architecture

The purpose of establishing a target architecture is to inform and guide the transformation of a fragmented legacy of processes (both manual and automated) and infrastructure into an integrated environment which is responsive to change, supportable, cost-effective to operate and which clearly supports the delivery of the business strategy.

Most often, reaching an optimal future state for an enterprise's architecture is best achieved on an evolutionary basis – not revolutionary. This is to say that where there already exist elements in the existing IT environment which are well-suited to form part of the desired end-state (as in the case of Halifax Water),

Mariner views that the best path to the target architecture is through incremental change and not through disruptive, wholesale replacement. This approach reduces the negative business impact of change and focusses investments on areas of greater strategic return.

Five Year Plan

Mariner recommends a five year plan and investment roadmap which will achieve the recommended transformation. This plan consists of a number of defined program initiatives, each supporting a key strategic theme, each supporting the evolution of the target architecture and each contributing to the continuous improvement of one or more facets of the IT environment: organization, applications and infrastructure. For a detailed explanation of these programs including purpose, scope, benefits, risks and estimated costs, please refer to *Appendix A: Program Charters* to this document.

This plan will require an IT investment commitment of approximately $5-7 M annually, over five years.

The programs which comprise the plan support the following transformational objectives:

- Evolve from static content on the Halifax Regional Municipality web site to a dedicated and engaging Customer Portal;
- Focus Customer Relationship Management systems on handling and managing customer service versus integrating features provided by backend systems;
- Leverage and evolve existing application suites;
- Evolve enhanced analytics with Enterprise Data Warehouse (EDW);
- Develop more reliable, portable and manageable Call Centre capabilities;
- Implement true document management practices;
- Improve the approval forms and team collaboration framework;
- Leverage native mobile application capabilities; and,
- Achieve a higher degree of system-to-system integration.

IT Organizational Evolution

Mariner found that Halifax Water has a good foundation of process and structure for the management of IT investments. Notwithstanding, there are opportunities for targeted organizational changes, increased governance, and continued growth of specialized skills in order to support increased activity, complexity, and integration requirements, which are expected over time.

Mariner identified the opportunity for changes in areas such as project portfolio planning and management, better architectural governance, improved vendor management processes, and disaster recovery planning.

Organizationally, Halifax Water would benefit from bringing application architecture and technology accountability into consolidated teams. Halifax Water will also need additional key staff resources in such areas as Architecture, Business Analysis and Business Change Management, with appropriate skill certifications, in order to accomplish the necessary transformations.

Introduction

Business Context

Halifax Water last developed an IT Strategic Plan in 2001. Since that time, they have been very progressive in using technology to improve organizational efficiency, operational effectiveness and customer service.

Halifax Water has made good investments, driven by that strategy, included SAP, GIS, Cityworks and, more recently, the Advanced Metering Infrastructure.

The Nova Scotia Utilities and Review Board has asked that another IT Strategic Plan be undertaken and submitted as public record to guide the next five years of investments in IT. This report marks the conclusion of that initiative and sets forth the findings, recommendations and a roadmap to guide IT investments over the next five years.

Strategic Business Drivers

There are a number of strategic business drivers which shape the information technology environment in Halifax Water:

- Providing world class services to our customers and our environment;
- Continuing to demonstrate leadership as an integrated water, wastewater and storm water utility;
- Retaining and improving position as a leading and progressive utility in all lines of business focused on:
    - Public and Employee Safety
    - Water Quality
    - Sustainable Infrastructure and Asset Renewal
    - Regulatory Compliance and Growth
    - Environmental Stewardship; and,
- Continued commitment to the 30-year Integrated Resource Plan (IRP) Framework, established in 2012.

As an overarching goal, Halifax Water wants to ensure that IT investments meet the future needs of the business, supporting the efficient and safe delivery of world-class, end-to-end services in all of its lines of business: Water, Wastewater and Stormwater.

Methodology

Overview

Mariner used a structured and proven strategic planning methodology, summarized in the following diagram:

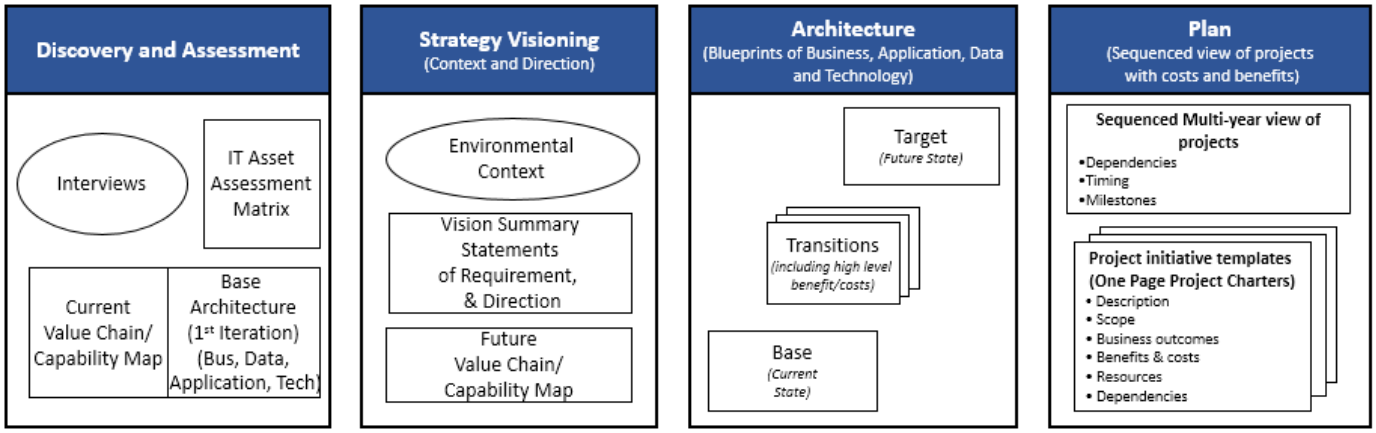


Figure 1: Structured Approach to IT Strategic Planning

Discovery and Assessment

During Current State Assessment, Mariner worked to discover and characterize, in detail, the current state of both the technology and technology management environment. At this time, the team also sought to develop a strong understanding of the broader business objectives and strategy – and particularly how they relate to current and future IT requirements.

To develop the required understanding of the IT environment and broader business, Mariner conducted consultations with key stakeholders throughout the organization. Consultations were structured to gain clarity and insight on a prospective vision for the future IT environment, and to capture an understanding of current business pain points that relate to existing IT environment and capabilities. Mariner also collected and reviewed a variety of documentation and other information necessary to develop a complete view of the technical and associated business environments.

The deliverables for this stage were an IT Assessment and IT Asset Matrix, which are summarized later in this document. These deliverables provide a characterization of the base IT architecture, an inventory of IT assets (including key attributes of each asset (including support arrangements, failure risk, failure impact, disaster recovery (DR) profile, cost, security, extensibility, and scalability), and a consolidated list of general observations and conclusions that have been developed during the consultations and discoveries.

Strategy Visioning

During Strategy Visioning, Mariner identified the critical drivers that should shape the formation of the IT Strategic Plan. The goal of this phase was to characterize a vision for the technology environment and the future management of IT to which Halifax Water aspires over the coming five (5) years. This vision serves as a compass to guide the formulation of a future (i.e. Reference) architecture, and also helps inform the priorities and sequencing of IT investments on the journey towards the Reference architecture.

The key output of Strategy Visioning was a concise vision summary consisting of a consolidated list of strategic and business requirements to guide and shape future deliverables.

Architecture

Mariner modelled a target architecture that reflects the end state application, data, and technology architecture required to support the vision. Once the target architecture was defined, Mariner reviewed it with the client and sought approval for the end state. The target architecture represents a long-term view of what eventually will be achieved (i.e. over five years). Consequently, annual intermediary (i.e. transition) state architectures were also developed to inform annual project and investment planning to move the base state environment to the target state over the five year planning period.

Plan

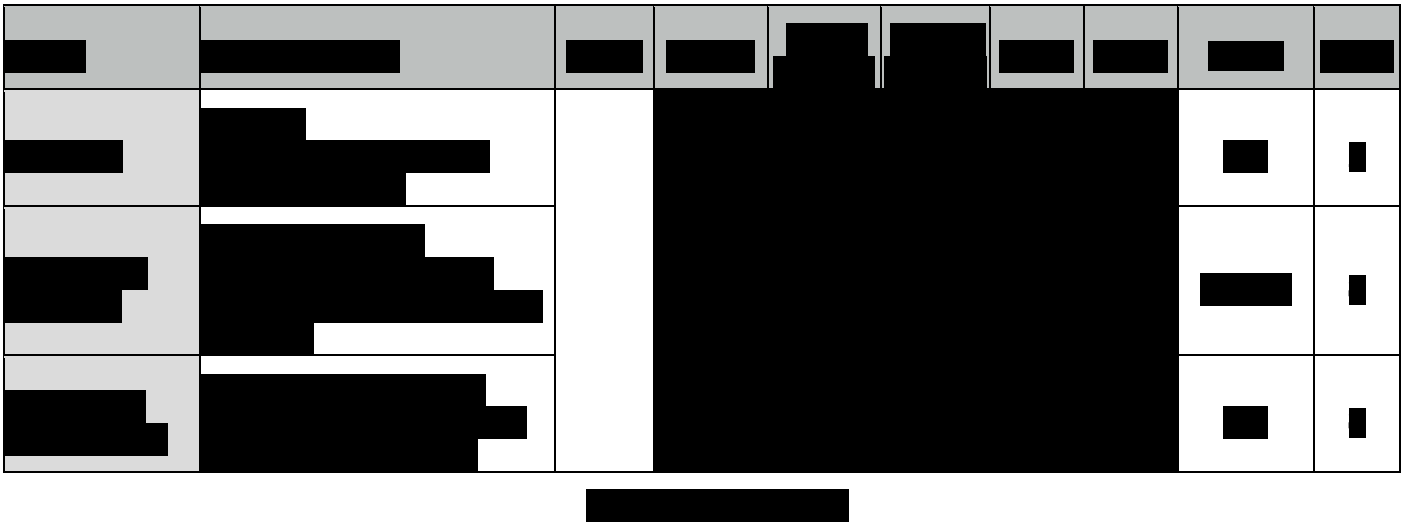
Mariner developed a recommended sequence of investments required to deliver on the agreed upon business outcomes and Reference architecture. This sequenced view of investments includes information on proposed projects and associated dependencies, business milestones, and other timing considerations.

The deliverable from this activity was a Five Year Plan which includes a portfolio of Program Initiative Templates (One Page Project Charters) that provide a description of the proposed project investments, including each project's scope, anticipated business outcomes, cost estimates, anticipated benefits, and resourcing considerations.

Current State Assessment

Due to the sensitive nature of the Current State Assessment, the information in this section has been redacted for security purposes.

[redacted]



[redacted]

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Relevant Industry Trends

Introduction

As with most industries, water, stormwater and wastewater utilities are becoming major users of IT with the goal of becoming more efficient and effective. Halifax Water is being very progressive in implementing new technologies including SAP, GIS, and SCADA. Many water utilities have recognized the value of AMI and are making investments in this capability. Halifax Water is leading in this regard and has a major program already underway to implement AMI across their customer base.

However, since technology continues to advance at an ever-increasing pace, there are still opportunities for Utilities and, in particular, Halifax Water, to take advantage of new technologies and procedures to help improve operations. At Halifax Water, we see the following processes and technologies as ones that could be explored to provide additional new benefits for customers and efficiencies for the business.

Cyber Security and Disaster Recovery Planning

The following quote comes from the **American Water Works Association** web site:

> *"Cyber security is the top threat facing business and critical infrastructure in the United States, according to reports and testimony from the **Director of National Intelligence, the Federal Bureau of Investigation and the Department of Homeland Security**."*
>
> *- February, 2014.*

With water systems being such a vital part of public infrastructure, it is imperative that these systems be kept safe and secure. Besides the necessary physical security, a utility should also have effective security with regards to its computer systems – i.e. cyber security. Cyber security is a combination of technologies, processes and practices designed to protect networks, computers, programs and data from attack, damage or unauthorized access. The proliferation of "ransom ware" has proven that even major organisations can be quickly "brought down" by a virus.

As well, ransom ware has also shown that every organization should have an effective Disaster Recovery plan that can be called upon when needed. One of the most effective responses to a ransom ware attack is simply to go to your system backups and recover.

During our research, cyber security is one initiative that many water utilities have identified as being a priority. This includes strengthening cyber security measures; continuous improvements to cyber security; redundancy, and disaster recovery and business continuity. Particular emphasis is being placed on protecting customer information, payment information, infrastructure data and plans, and SCADA.

Advanced Metering Infrastructure (AMI)

Advanced Metering Infrastructure (AMI) is another area in which many water utilities are making major investments. AMI refers to systems that measure, collect, and analyze water usage, and communicate with water metering devices, either on request or on a schedule. These systems include hardware, software, communications, consumer energy displays and controllers, customer associated systems, meter data management software, and supplier business systems.

The benefits of an AMI are numerous. With the detailed usage data available in an AMI system, **customer service** representatives have immediate access to consumers' consumption information. When a customer calls with a high water bill complaint, the CSR can provide a complete picture of water usage and patterns. The ability to communicate this level of information to the customer not only adds validity to the accuracy of the meter, it also makes for better customer service through the faster resolution of issue.

AMI also provides water utilities with the ability to change to different billing cycles (monthly, for example, or more often for certain customers).

Not having to manually read meters or physically investigate a high water bill complaint means not having to roll a truck. This results in cost savings on gasoline and vehicle maintenance, plus a lower carbon footprint. Using AMI to automate many of the traditionally manual functions of water utility staff will enable the utility to transition its workers into more critical roles.

AMI can provide significant benefits with respect to **conservation**. For example, a utility in a water-stressed area might have customers on a personalized budget rate for a particular household size. If customers exceed their allocations, they could be subject to a higher usage charges or penalties. With AMI, the utility can inform customers how they are tracking against their budgets on a day-to-day basis, providing timely feedback and enabling customers to adjust consumption. This emphasizes budget rates as a useful tool for conservation.

Cloud Computing

Cloud computing has been mainstream for only a short time but it has proven to be a very successful business model. It can be described as "the practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer". For a brief explanation of cloud computing, please see *Appendix B: Cloud Computing.* A major advantage to this technology is that the organization no longer has to manage the server technologies required for the applications. To a large degree, redundancies, backups, disaster recovery scenarios and system security are performed by the cloud provider and assured through contractual service level agreements. Cost for these services are typically based on usage.

However, by being "in the cloud", organisations become dependent on third parties to provide these services and rely on internet connections which are reliable and of sufficient speed to support required operational needs. In many cases, these factors are beyond the direct control of the subscribing organisation. Particularly with regard to networking, organisations relying on cloud computing resources need to pay careful attention to ensuring that the necessary redundancies and backups are in place for internet connections. (For example: multiple network providers).

There is also an alternative to putting everything in the cloud, which is called a hybrid solution. In this case, some applications can reside in the cloud and others can remain on dedicated server computers, on organisations' premises.

Business Intelligence and Reporting Systems

Advanced analytics help many water utilities forecast needs, identify opportunities for cost savings, enhance preventive maintenance, identify patterns of risks and performance, and proactively flag issues for further attention. A good monitoring function will track decision-relevant information, present critical information in digestible formats, and enable users to drill down as required.

Analytic tools can include such items as reporting and analysis tools, dashboards, portals, data warehouse, and business intelligence applications.

The goal of these tools is to transform data into meaningful information that can support decisions associated with business and operational performance. Some of the benefits of these types of systems are:

- Improve consistency and accuracy of reporting;
- Reduce stress on operational systems for reporting and analysis;
- Provide faster access to information;
- Provide increased analytical capabilities;
- Help forecast needs (i.e. inventory);
- Identify opportunities for cost savings;
- Enhance preventive maintenance;
- Identify patterns of risk and performance;
- Proactively flag issues for further attention; and,
- Empower the end-user.

A major benefit associated with such a solution is **easier access to the best available information.** Wherever the data resides, whether it is stored in operational systems, data warehouses, data marts and/or packaged applications, users can prepare reports and drill down into the information to understand what drives their business/operations, without requiring technical knowledge. The most successful analytic applications allow users to do this with an easy-to-understand, non-technical, graphical user interface. This speaks to the benefits of **managed data integration** in support of business intelligence and reporting needs.

Customer Portal

Many water utilities are investing in **customer portals** which improves the customer experience by providing such features as:

- Enabling customers to answer their own billing/usage questions;
- Encouraging customer self-service and lowering call center traffic;
- Customers can start, stop and manage services;
- Reducing wasted water;
- Providing electronic billing;
- Providing an on-line payment service;
- Generating positive public relations value;
- Providing customers with information about outages and restoration times;
- Customers can receive notification of possible leak conditions and prevent property damage;
- Customers can see how much water they are using;
- Customers can see how their usage compares to similar households/properties;
- Keeping a history of alerts, notifications, and other communications that customers can review;
- Enabling customers to easily contact and communicate with the utility team; and,
- Enabling customers to obtain information and communicate with the utility via social media.

Geographic Information Systems (GIS)

Halifax Water has been a major user of GIS for a number of years now and is well-versed in the many capabilities of GIS. One area of opportunity for Halifax Water to further the use of GIS is to **integrate the GIS database with other operational databases within the organization.** For example, establishing common database links between the GIS and customer records system could let Halifax Water associate real-time demand usage with the GIS network model. This is useful in supporting modeling and other analysis/reporting capabilities. Network tracing functions within the GIS can also provide useful reports such as a list of customers impacted by valve closures, identification of "critical" customers served by a section of the system, or a mailing/notification list of specific customers in a certain area.

Relating customer records to geographic locations can provide additional customer service benefits. When a customer calls with a complaint, the customer service agent could immediately see the location of the current complaint as well as any recent complaints nearby. A work order tied to that location could then be generated.

Many utilities are now taking GIS data out into the field where it can be directly used to support maintenance activities, facility inventories, construction, location of buried facilities, etc. Such use eliminates many labour-intensive activities such as manual entry of field collected data forms, data consolidation at the office, additional quality control verifications, and field re-visits.

Asset Management

Aging infrastructure, demands imposed by growth, and concerns about system optimization continue to fuel interest in improving asset management. Computerized systems are an excellent tool for planning and scheduling work activities such as valve and hydrant maintenance programs or pipe cleaning and inspection programs.

Computerized systems specifically developed to improve asset management include Computerized Maintenance Management System (CMMS) and Work Order Management (WOM). These database applications are often the primary source of attribute information for pipes, fittings, valves, and other components of distribution systems. They are often used to track material inventories and work-order purchases. Linking this asset data to the GIS relates it directly to the network system without the need to re-enter it or maintain a duplicate data set.

Field Data Collection

Utilities continue to invest in and extend systems which collect operational data and service information directly from the field. Handheld, ruggedized computers with combined GIS/GPS capabilities provide:

- Immediate ties to location and other features (even photos)
- Review of existing data used to support field activities
- Immediate validation of previously and newly collected data
- Reduced need for field sketches to show facility layouts
- Elimination of data re-entry

Mobility

Wireless computer networks have dramatically opened up the ability to "do business" when outside of the office environment. Smartphones and network connected tablets can now be used to collect geospatial data or explore it visually, anywhere and at any time. Professionals in the field can use these applications for data collection or as observational data, which they can then bring directly into an enterprise services systems. Customer service and engagement can be greatly enhanced by extending features and access to consumers' mobile devices.

Technology now allows organizations to put programs on smartphones, tablets and laptops which can connect to backend applications and data stores. The low cost of these devices coupled with the relatively low cost of cellular data networks provides significant opportunities to deploy mobile applications which can support water and wastewater operations, maintenance, and customer service. Most software vendors now offer mobile applications for their products that provide a subset of the features available for the normal desktop computer users. In addition, it is relatively easy to develop custom applications for mobile devices that can meet specific needs of the users to have real-time access to database information and provide real-time updating of database information.

Some potential areas for the use of mobile computing at Halifax Water would include:

- Improved customer service and community engagement – allowing customers to view, understand and pay bills, get information about service interruptions, report problems, view consumption patterns and learn and participate in conservation programs.

- Customer field service – enable customer service agents to receive and originate information while they are mobilized and interacting with customers. Utility customers benefit with faster, more responsive service, and utilities benefit with more efficient utilization of field service resources.

- Distribution network maintenance – distribution system maintenance can benefit from using mobile applications for work order management, asset locating and mapping. In this case, the benefits are related to efficient use of staff time and more timely communication of maintenance needs. These refinements can result in lower overall costs for distribution maintenance.

- Plant maintenance – a lower cost maintenance function is also possible within plant boundaries when employees can work untethered from desktop computers. Mobile devices are also appropriate to a limited extent in warehouses, to enable more productive counting, picking, and restocking.

- Workflow authorization – for reviews and approvals related to finance, purchasing and human resources, utility managers can benefit with mobile applications that permit them to be away from their offices and still conduct business within their scope of authority.

Summary

Generally, Halifax Water measures well in relationship to identified industry trends, with good investments and ongoing work in many areas to continue to improve. Two areas most deserving of increased focus are Cyber Security/Disaster Recovery and generalized analytics.

Strategic Vision

Introduction

In establishing an IT strategy and roadmap, which will guide and inform the next five years of investments, it was necessary to establish a clear strategic vision for how Halifax Water wants to position and utilize information technology in the context of its business and utility operations.

The purpose of this section of this document is to summarize the IT Strategic Vision which was established by reviewing stakeholder input, industry trends, business drivers and the current state of IT within the organization.

Vision Statement

Halifax Water's Strategic Vision for IT is summarized by the following statement:

> *Halifax Water wishes to be an innovative user of established technology to enhance their customers' experience, improve performance, manage the inherent risk of being a public essential operation and have engaged employees with the tools to do their work effectively, all while maintaining fiscal responsibility.*

Halifax Water wants to be innovative in its use of information technology however such technology should be established so as to mitigate the risk of employing unproven technologies in providing critical infrastructure and services. It emphasizes the importance of key goals in the areas of customer experience, the significance of maintaining public trust in being a provider of critical infrastructure and services while maintaining fiscal responsibility.

Key Drivers

The Vision Statement reflects the identified Corporate Balance Scorecard indicators for IT investments:

- Service Excellence;
- Effective Financial and Asset Management;
- Regulatory Compliance;
- Motivated, Satisfied Employees and Work Safety; and,
- Financial Management and Security.

IT Strategic Themes

Mariner identified six key themes which characterizes the strategic focus for IT investments for the next five years. For each of these themes, there is a target end state which reflects broad goals over the planning period.

The following table summarizes the IT Strategic Themes and illustrates their relationship to the identified Key Drivers.

Drivers	Strategic Themes	End States
Service Excellence	Customer Experience	Customer can perform all services using the online site or mobile.
Effective Financial and Asset Management	Integrated Information with Location	Having all necessary data linked together and also tracked to location. Having the ability to access information and trends through a geographic lens.
	Analytics Driven Decision Making	Able to model using all customer usage data, environmental data, and infrastructure data across the Water, Wastewater and Stormwater systems. Able to tie financial, operational, and system data together into business intelligence.
Regulatory Compliance	Managed Knowledge and Workflow	Key content is stored logically and easily accessible by those that require it. Key processes and policies are guided and monitored for employee effectiveness and regulatory compliance
Motivated, Satisfied Employees and Safety	Enable Employees Anywhere	Employees can access, capture and update the information they need to effectively do their job and support others, wherever they may be working (Mobile, Office, Home)
Financial Management and Security	Secure IT Foundation	Infrastructure is resilient, cost effective, well supported, and recoverable within critical RTO (Return To Operations) and RPO (Restore Point Objectives) requirements

Figure 3: IT Strategic Themes

Current Assessment, Industry Trends and Strategic Themes

The following table summarizes and shows the relationships between the key findings of the Current Assessment, Industry Trends and Strategic Themes.

Current Assessment Findings	Industry Trends	Strategic Theme
Customer Relationship Management (CRM) implemented as a transition solution Current website strategy is misaligned Call Centre management platform is end of life Halifax Water needs to develop a clear business strategy and architecture for CRM and Customer Self Service	Customer Portal	**Customer Experience**
Amount of departmental applications and integration requirements have been growing. HRWC have not invested in "Integration Capabilities"	Asset Management Geographic Information Systems (GIS)	**Integrated Information with Location**
	Data Analytics Advanced Metering Infrastructure (AMI)	**Analytics Driven Decision Making**
GIS and SAP make up close to half of the IT operational budget	Authorized Workflow	**Managed Knowledge and Workflow**
Halifax Water does a good job of lifecycle management and supporting workstations	Mobile Computing	**Enable Employees Anywhere**
No Disaster Recovery objectives, plans or environments for a number of key systems. Current state of in-house Data Centre is a risk.	Cloud Computing Cyber Security and Disaster Recovery Planning	**Secure IT Foundation**

Strategic Milestones

In formulating the five year roadmap for the IT Strategic Plan, it is useful to establish some milestones, by fiscal year, for evolving and achieving elements of the Strategic Vision end states.

The following table summarizes the Strategic Milestones and illustrates their relationship to the Strategic Themes:

Themes	FY 2018/2019	FY 2019/2020	FY 2020/2021	FY 2021/2022	FY 2022/2023
Customer Experience Online	• Host own website with link from Halifax.ca	• Track incoming contacts and link to work orders where applicable • Customers can monitor usage online • Permits requests online • Skills based routing and queue management • Contact Centre Quality Assurance	• Agents enabled with simplified tools • Contact triage ability • Monthly Billing • Locate Service Online	• Customer mobile access • Simple online bill • Account management functions online	• Most services are available online and mobile
Information Integration with Location	• Latest GIS platform • Improve Locate Service • GIS Core System upgraded • Drawing Database in place • Asset Registry implemented	• All assets linked to GIS • Improved asset criteria selection process	• Ability to better collect data in the field • Better inventory, location identification of capital equipment	• Better location view into Analytics and Dashboards. • More varied data available for analytics	• GIS is linked to Customer records, Asset records and Work activity • Key GIS data is up to date and maintained
Analytics Driven Decision Making	• New continuous WW/SW hydraulic modeling tool • AMI IT foundation work complete	• All customers on AMI meters • Enterprise Data Warehouse (EDW) in place	• Reduction of wastewater overflows • Further reduce leakage • Asset Assessment Analytics	• Wet Weather Program data integrated. • Financial and Work Activity part of dashboard.	• Dashboards used for Operations and Planning. • New water hydraulic modelling

Themes	FY 2018/2019	FY 2019/2020	FY 2020/2021	FY 2021/2022	FY 2022/2023
Managed Knowledge and Workflow	• Document standards in place • More Work orders automated • All new content stored in Enterprise Content Management platform • Improved project planning and lifecycle processes.	• Improved maintenance planning support • New permit process with HRM • Regulatory compliance	• Approval Form development environment in place • Most corporate forms in place • Integrated Resource Plan	• Team sites and collaboration capabilities	• Synergies across Water, Wastewater and Stormwater
Enable Employees Anywhere	• Simplified access to documents	• Agents can work remotely • Secure Remote Access	• IT managed smartphones and tablets • Approval Forms and Documents available on mobile devices.	• More applications available on mobile • Employee Self Service	• Customer online capabilities available to field and agents • Mobile Employees are enabled with right device
Secure IT Foundation	• Central IT Governance • DR plans established • All applications well supported	• Data Centre replaced • Critical applications hosted • Office 365 conversion • Evolved Vendor Management	• IT is focused on Applications, integration, Security, Mobile and Devices	• IT support, availability and security maintained	• IT support, availability and security maintained (repeated from previous year)

Figure 4: Strategic Themes and Annual Milestones

Architecture

Introduction

The purpose of architecture is to optimize, across the enterprise, the often fragmented legacy of processes (both manual and automated) and infrastructure into an integrated environment that is responsive to change, supportable, cost-effective to operate and supportive of the delivery of the business strategy.

This section describes, at a high-level, the IT architectural strategy for Halifax Water, showing key application systems and infrastructure, expressed in terms of an evolution from the current state to the desired target state, within a five year planning horizon.

Application Strategy

Current and Target Application Models

Most often, reaching an optimal future state for an enterprise's architecture is best achieved on an evolutionary basis – not revolutionary. This is to say that where there already exist elements in the existing IT environment which are well-suited to form part of the desired end-state (as in the case of Halifax Water), the best path to the target architecture is through incremental change and not through disruptive, wholesale replacement. This approach reduces the negative business impact of change and focusses investments on areas of greater strategic return.

The following chart shows the transition from the current architecture to the proposed target architecture. Certain elements in the current state will be preserved ("Maintain"), some will be preserved with improvement ("Change") and some will be replaced ("Replace"). New elements, not currently existing, will be added and integrated within the environment ("Add").

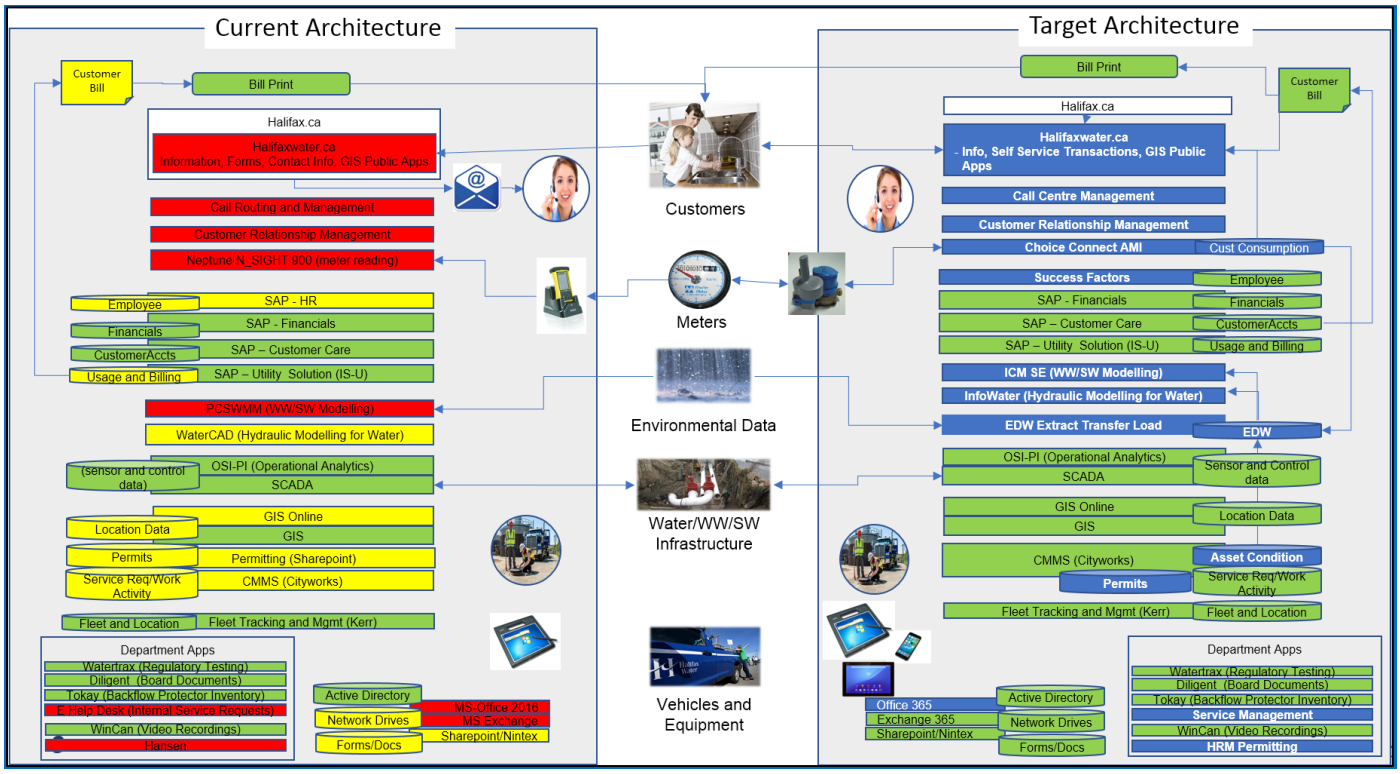

Figure 5: Current and Target Architecture Models

Required Architectural Changes

In order to transition from the current to the target application architecture, the following major changes are required and guide the formation of the five year roadmap plan:

1. <u>Evolve from static content on HRM's web site to a dedicated and engaging Customer Portal</u>

   Currently Halifaxwater.ca is part of Halifax.ca website and there is limited support for customer transactions or active features which would improve customer service and engagement. It is essentially static information and forms, with some limited integration in the form of GIS online access to informational applications.

   This change will entail:

   - Migrating the Halifax Water web content and applications away from the HRM site, leaving an intelligent link for navigation purposes and allowing for greater autonomy and flexibility in providing customer-centric features;
   - Investing in more transactional, dynamic content and technologies to establish a more useful and engaging Customer Portal; and,
   - Integrating with the current and planned internal systems.

2. Focus CRM on handling and managing customer service

   One approach to providing a unified toolset to support the customer service agent would be implement all transactional processing features within the CRM layer itself. This approach would be costly and would result in an increasingly brittle solution. A better strategy is to view the CRM layer as an integrated agent portal, which would provide agents with unified access to service features of existing core application systems (such as Cityworks, SAP IS-U).

   The implications of this change are:

   - The evolution of a CRM feature set would focus solely on customer information, service information, relationship management, and contact history; and,
   - Service requests, account transactions, work activity would be accessed through a unified view in the CRM layer, but would obtain data through integration with available customer/account care features in core systems.

3. Leverage and evolve existing application suites

   Rather than building too many point solutions or replicating functionality across multiple applications, Halifax Water will leverage as much of the specialized capability that is available in existing suites as is practical. This helps optimize across the business and keeps cross system integration requirements low.

   This will lead to some changes to the roles of existing application systems, which may, in turn, require additional modules, integration or application upgrades:

   - Cityworks has features which support aspects of Permitting and Asset Management processes. The investment in this application should be leveraged further as a key part of the broader solution for Permitting and Asset Management;
   - The Customer Care features in Cityworks and SAP IS-U should be leveraged; and,
   - Halifax Water will take full advantage of SAP by applying the Success Factors upgrade for HR, assuming there is a cost-effective business case.

4. Evolve enhanced analytics with Enterprise Data Warehouse (EDW)

   Currently, there are a number of files from proprietary applications which feed the Hydraulic Modelling tools, along with OSI-PI, which stores historical SCADA data. There is a broader range of data inputs required to achieve the desired capabilities for analytics and decision support.

   Halifax Water needs to implement a managed Data Warehouse which stores and connects to new AMI consumption data and different sources of historical activity data (such as OIS-PI) for analytic purposes. The new Data Warehouse would become a unified and authoritative source for analytic and decision support data.

5. Develop more reliable, portable and manageable Call Centre capabilities.

   The current Call Centre routing platform is at end-of-life and does not provide the necessary features to manage and operate an integrated, multi-request call centre.

   Halifax Water should replace its end-of-life platform with a Voice over IP (VoIP) based cloud solution for features such as call distribution, call integration and business continuity.

6. Implement true document management practices

   Current document management and sharing relies on complex, hierarchical folder structures, stored on shared network disk drives. This approach has some weaknesses. The system is complex and difficult to navigate, requiring an understanding of the hierarchical structure, in order to efficiently locate files and information. As well, the administration of this solution (content, permissions) is more complex and generally cannot be delegated to information "owners". Version control is not built in and relies on either file-naming strategies or folder organization.

   Halifax Water needs to implement a proper document (knowledge) management solution with access tools which enable search and filtering, version control and distributed administration. Documents should be stored with attributes (meta-data) which enable searching. The physical storage of the documents and files should be transparent to the end-user.

7. Improve the approval forms and team collaboration framework.

   Computerized forms have been implemented using a number of different technologies by different departments including: Adobe Forms, Microsoft SharePoint and Microsoft Word. The inconsistency in the approach and tools makes it difficult to support these capabilities and for employees to use them.

   Halifax Water should develop an environment where departments can construct their unique forms in a way in which the form development, approval flows, storage and access method is consistent and maintainable. Halifax Water should re-evaluate the use of the current underlying technology (Nintex) which does not fully meet needs.

8. Enable the use of native mobile applications.

   Currently, users of Cityworks are using the web-based desktop interface on their mobile devices which does not take full advantage of device features such as GPS and camera.

   In order to fully leverage mobile device technologies, the IT organization should assume ownership of Mobile Device Management (this does not necessarily preclude a "bring your own device" policy) and should enable the features on the backend systems which support native applications on the devices.

9. Achieve a higher degree of system-to-system integration.

   Currently, there is some integration between applications – mostly using batch file processing and manual processing. The target architecture will require many more real-time connections, either through transactional processing or shared data resources. This is key to decreasing manual interface effort, improving data currency, reducing redundancy and improving data integrity across systems.

   This will require:

   - Examining and analyzing business processes end to end to identify integration points;
   - Establishing and using clear standards and policies for integrating systems;
   - Establishing project governance procedures and policies to ensure that upgrades are synchronized so as not to break points of integration; and,
   - Changes to ensure that the increase technical and support complexity will be effectively managed.

Infrastructure Strategy

Current and Target Infrastructure Models

The following diagram depicts a conceptual view of the infrastructure current state at Halifax Water and the proposed transition to the future state.

The primary nature of the change is to move more completely to a combination of public, dedicated and private cloud solutions, eliminating the need for the Halifax Water and HRM Data Centres

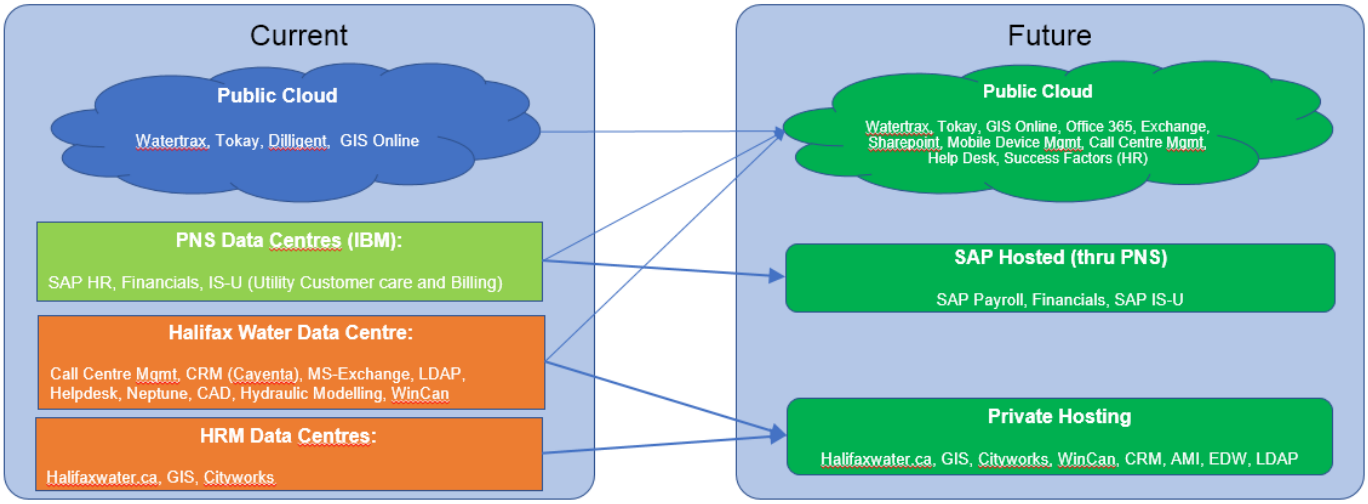

Figure 6: Current and Target Infrastructure Models

Required Infrastructural Changes

1. Migrate to more cloud-based solutions

   Implications:

   A hybrid cloud solution will require new multi-vendor management policies and procedures. Application and data backup and Disaster Recovery need to be an integral part of the cloud solutions.

2. Maintain agreement with the Province of Nova Scotia as they move to an SAP hosted data centre

   Implications:

   This should be a transparent change for Halifax Water, so long as PNS maintain (or improve) the current Service Level Agreement.

3. Move on premise applications and applications hosted at the HRM data centre to a private hosting solution.

   Implications:

   This will result in a reduced need to maintain computing infrastructure on premise at Halifax Water. Capacity and technology upgrades will be managed by the partner and guaranteed to Halifax Water through Service Level Agreement. The IT organization in Halifax water will become much more focussed on supporting the applications (administration and end-user support) versus the infrastructure. Backup and Disaster Recovery must be part of the agreement and provided by the partner.

4. Establish a Disaster Recovery Plan with environments which can be provided on demand.

   Implications:

   Halifax Water will need to establish clearly documented Disaster Recovery plans and objectives. Disaster Recovery must be incorporated into partner and cloud vendor contracts and SLAs.

Five Year Plan

Introduction

The five year plan and investment roadmap is a high level snapshot in time of the sequence of programs and investments to deliver on the approved technology vision and recommended architecture. As with most strategies with a multi-year planning horizon, certainty regarding the program and timing of individual elements diminishes in later years. It is important to view this program plan as guiding and instructing investments over the planning period. This strategy will evolve as progress is made and as new business factors emerge. For this reason, we have specifically included a program for the annual review of the current situation and refreshing the rolling five year plan and investment roadmap.

Finally, while the roadmap identifies specific programs and initiatives, nothing in the strategy obviates the need for rigorous business case analysis in support of investment decisions and projects.

Critical Success Factors

Organizational and stakeholder commitment to the success factors listed below is critical to the successful realization of the end-states identified in the vision:

- Commitment to initial investment in Enterprise Portfolio and Project Lifecycle and IT Foundations as a base for implementing the functional programs;
- Adherence to business case and planning discipline for each program/project in the roadmap;
- Clear ownership, and visible management support and commitment to the programs;
- Architectural governance across these programs to ensure integrity and integration;
- Commitment to a $4-6 M annual investment in IT;
- Assignment of experienced resources in key program roles: Program/Project Manager, Lead Architect, Business Change Manager, Lead Business Analyst;
- Acquisition of skilled and knowledgeable resources to supplement internal staff;
- External resourcing strategy to maximize value and effective management of consultant costs;
- Annual re-assessment of roadmap and programs for progress, resourcing, interdependencies, etc.:
    - Assess resource capacity and conflict,
    - Assess business change capacity in the detail planning,
    - Evaluate achieved outcomes and update expected outcomes for future years accordingly; and,
- Re-assessment of the roadmap on the completion of five year business strategy and plan.

Investment Roadmap

The Investment Roadmap establishes a plan, spanning five years, which delivers on the vision end states and milestones by implementing the target architecture and infrastructure models.

The roadmap is comprised of a series of defined program initiatives each which contribute to the realization of the desired future state and which support the key strategic themes for IT at Halifax Water.

The following chart depicts the high level timeline, in terms of fiscal years. (Note that the "zoom" tool can be used to increase the legibility of this chart):

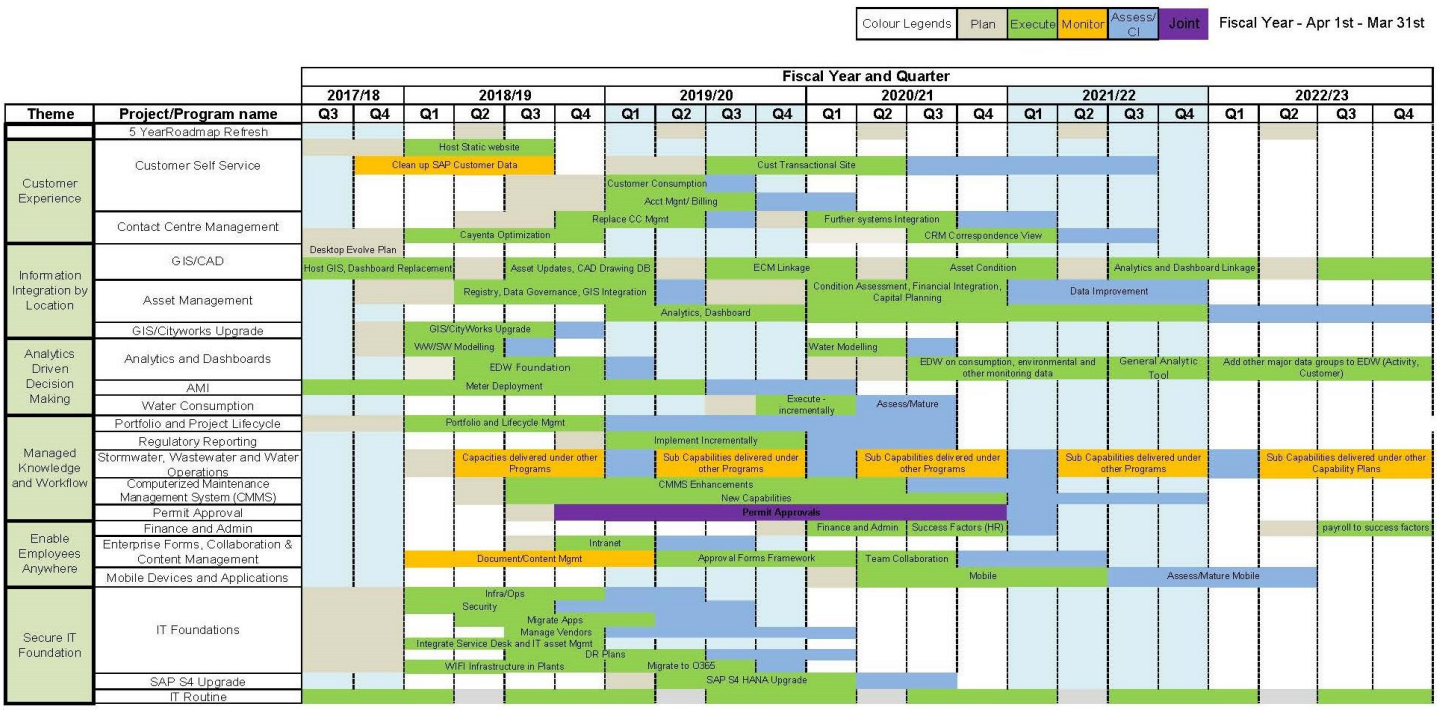

Figure 7: Five Year Investment Model

Program Charters

This section contains a summary of the program charters for the proposed initiatives, to be undertaken over five years, in order to achieve the vision end-state. For full program charter details, please refer to *Appendix A: Program Charters.* With the exception of the first program (*five year Roadmap Refresh)* which ensures that the overall strategic plan is kept current year over year, these are organized by the IT Strategic Themes which they support:

- Customer Experience;
- Information Integration with Location;
- Analytics Driven Decision Making;
- Managed Knowledge and Workflow;
- Enable Employees Anywhere; and,
- Secure IT Foundations.

Programs Supporting Customer Experience

Customer Self Service

Description:	Development of transactional public website where customers can perform their own transactions, such as initiating a permit, logging a complaint, checking their water consumption, checking their bill or ordering new service installation.
Benefits:	• Lower unit cost to deliver target level customer service through deflection of Contacts from agents to self-service. • Improved customer service and engagement, • HW brand viewed by Customers and other external stakeholders as being innovative and advanced.
Approx. Cost:	$1.36M – 2.22M

Contact Centre Management

Description:	This program is focused on the Customer Contact Centre, improving the following capabilities: • Provision of a single point of contact and tracking for all customer related requests, inquiries and issues - one contact resolution. • Direction/Facilitation of all field work undertaken on behalf of customer. • Management of contact quality (through skill based routing, call recording, reporting, etc.).
Benefits:	• Improved Customer Care productivity and effectiveness • Brand and customer satisfaction • Employee morale
Approx. Cost:	$1.2 M – $2.25 M

Programs Supporting Information Integration with Location

GIS/CAD

Description:	This ongoing program will continue to provide GIS and CAD services to the organization including annual assessment of the data and application requirements necessary to provide these services. The annual assessment will be included the development of a specific action plan. This program will work closely with Data Governance and Asset Registry initiatives so that categories of data within or linked to GIS, can be provided efficiently for integration point functionality required to support other key capability programs.

Benefits:	• Record Accuracy
	• Improved Corporate Productivity
	• Supports Capital Budget No Regrets Policy:
	  ○ Firm Regulatory Requirement
	  ○ Asset Management Program
	  ○ Wet Weather Program

Approx. Cost:	$4.5M – $5.2M

Asset Management

Description:	This program will clearly identify the necessary asset data that should be stored and ensure they are established in the appropriate databases (Cityworks, GIS, SAP). This program will lay out a sequenced plan for initial "loading" of condition, classification and linkage data (i.e. asset tag for financial) into those databases. The program will ensure that dashboard and analytics requirements are fully understood and provided to guide delivery through Cityworks, dashboards and analytic tools. This program will also identify methods for continuous capture and maintenance of the Asset Conditions as changes occur (i.e. maintenance or replacement).

Benefits:	• Better System Performance
	• Capital Efficiency
	• Supports Capital Budget No Regrets Policy:
	  ○ Required to ensure infrastructure system integrity and safety
	  ○ Directly supports the implementation of the Asset Management program
	  ○ Directly supports the implementation of the Wet Weather Management program
	  ○ Growth related infrastructure supported by pre-design level master plan

Approx. Cost:	$1.93 M – 3.63 M

GIS/Cityworks Upgrade

Description:	This ongoing program will continue to provide GIS and CAD services to the organization including annual assessment of the data and application requirements necessary to provide these services. The annual assessment will be included the development of a specific action plan. This program will work closely with Data Governance and Asset Registry initiatives so that categories of data within or linked to GIS, can be provided efficiently for integration point functionality required to support other key capability programs. .

Benefits:	• Record Accuracy
	• Improved Corporate Productivity
	• Supports Capital Budget No Regrets Policy:
	  ○ Firm Regulatory Requirement
	  ○ Asset Management Program
	  ○ Wet Weather Program

Approx. Cost:	$1.2 M – $2.25 M

Programs Supporting Analytics-driven Decision Making

Analytics and Dashboards

Description:	This program will allow key historical data to be aggregated and made available to hydraulic modelling and corporate analytic tools. This program will also replace current suite of hydraulic modelling tools and introduce general purpose corporate analytic tools.

Benefits:	• Better system decision making
	• Corporate Productivity
	• Improved Service Levels
	• Supports Capital Budget No Regrets Policy:
	  ○ Directly supports the implementation of the Asset Management program
	  ○ Directly supports the implementation of the Wet Weather Management program

Approx. Cost:	$628K – 1.24M

Water Consumption

Description:	This program will develop new strategies and capabilities to use advance metering capability at the point of use to improve Operations, Cost and Customer Service.
Benefits:	• Reduction in non-revenue water consumption • Consumer-driven demand management and reduction (conservation) • Brand Value – Water Conservation ○
Approx. Cost:	$100K - $200K

Programs Supporting Managed Knowledge and Workflow

Enterprise Portfolio and Project Lifecycle

Description:	This program will define and develop the necessary processes and competencies to enable HW to effectively assess and prioritize business opportunities and to efficiently initiate, plan, implement, and assess the impact of capital projects arising from those business opportunities.
Benefits:	• This program is designed to improve business performance: ○ Help make explicit and verifiable business cases for IT/Corporate Change Programs ○ Reduce the risk of cost and timeline overruns ○ Rapidly and cost effectively course correct the program's direction as new information becomes available ○ Help build a culture of engaged workforce
Approx. Cost:	$276K – 381K

Regulatory Services

Description:	The goal of the program is to make regulatory requirements for Reporting (Capturing the Data and Reporting back to authorities) an integral part of data collection, synthesis, analysis and dissemination to improve customer service, HW operations and costs to manage water, wastewater and stormwater.
Benefits:	• Supports Capital Budget No Regrets Policy: ○ Firm regulatory requirement • Improve business performance: ○ Understand the total cost to manage a regulation and develop strategies to minimize cost/improve the value ○ Gain Customer Satisfaction that HW is using Regulations to improve business performance
Approx. Cost:	$300K - $500K

Stormwater, Wastewater and Water Management

Description:	This program will Review the Stormwater, Wastewater, and Water operational processes end to end to ensure functional improvement requirements are provided to the appropriate Capability under the proper program. Implement the Change Management to process, policy and roles in the Stormwater, Wastewater, and Water operations.
Benefits:	• Supports Capital Budget No Regrets Policy: ○ Required to ensure infrastructure system integrity and safety ○ Directly supports the implementation of the Asset Management program ○ Directly supports the implementation of the Wet Weather Management program
Approx. Cost:	$465K – $750K

Computerized Maintenance Management System (CMMS)

Description:	This program will continue the momentum of the current Operational Maintenance Management (OMM) Program. The focus of this program will be to complete the delivery of standardized work orders via templates and continue the integration with other back end systems.
Benefits:	• Operational efficiency • Increased employee morale
Approx. Cost:	$1.75M – $2.47M (excludes cost of current Cityworks program)

Permit Approval

Description:	There is a recently completed tactical project that replaced the HP3000 based application with workflow on SharePoint. While this tactical project eliminated HP3000 technology from current list of managed technologies by internal IT, a long term solution that meets the needs of both internal and external stakeholders is still required. This new project will determine business requirements for Permit approvals at Halifax Water and integrate into the Permitting system at the Halifax Regional Municipality
Benefits:	• Operational efficiency • Increased customer satisfaction • Increased employee morale
Approx. Cost:	$668K – 917K

Programs Supporting Enabling Employees Anywhere

Finance and Administration

Description:	The goal of this program is leverage SAP based HR and Finance systems (explore add on tools and approval forms use where appropriate) to improve operational efficiency across the organization.
Benefits:	• Operational efficiency • Reduce costs to manage time and attendance • More effective allocation of time to projects • Value of employee generated and lead opportunities both within and outside the HW organization • Demonstrate to staff and public that the organization is investing in good management practices
Approx. Cost:	$800K - $1.4M

Enterprise Forms, Collaboration and Content Management

Description:	This program will deliver the necessary frameworks, environments, and business change support for true document management, approval forms management, and team collaboration.
Benefits:	• Increased employee productivity • Meets compliance requirements • Reduction of errors • Supports Capital Budget No Regrets Policy: ○ Firm Regulatory Requirement
Approx. Cost:	$850K – 1.47M

Mobile Devices and Applications

Description:	This program will establish effective management of corporate smart phones and tablets, introducing ”native apps” for key system and expanding the use of mobile devices to mobile employees.
Benefits:	• Improved employee productivity • Increased employee satisfaction • Improved security • Improved data quality
Approx. Cost:	$400K - $900K

Programs Supporting Secure IT Foundations

IT Foundations

Description:	The goal of this program is to define and implement suitable IT Infrastructure and necessary processes, competencies and governance to both efficiently support the current business operations and ensure advances in IT capabilities can be effectively leveraged.
Benefits:	• Improved time to market for new capabilities • Improved ability to control cost and IT risks • Improved ability to deploy IT infrastructure to meet the changing needs of the business. • Streamlined Decision Rights (Governance) of IT Operations across the organization.
Approx. Cost:	$2.48M – $2.72M

SAP S4 Upgrade

Description:	The province is driving an upgrade to the new SAP S4 platform. With this upgrade comes major changes in user interface, and a move to the Success Factors platform for Human Resource Management. This program will ensure that the changes are effectively introduced and managed in Halifax Water and that the full benefits of the upgrade will be realized.
Benefits:	• Enhanced HR • Public Web Site Integration
Approx. Cost:	$1.2M - $1.6M

IT Routine

Description:	This is an annual program to manage the lifecycle and maintain the on premise infrastructure (Networking and End Point Devices) and to ensure applications are kept current as required.
Benefits:	• Reliable and supportable technologies
Approx. Cost:	$400K - $600K / year

IT Organizational Evolution

Introduction

Halifax Water has a good foundation of process and structure for the management of IT investments. Notwithstanding, there are opportunities for targeted organizational changes, increased governance, and continued growth of specialized skills which will support increased in activity, complexity, and integration requirements, expected over time.

Implementation of many of these changes will be early in the Enterprise Portfolio and Project Lifecycle and IT Foundations programs.

Current IT Management Environment and Recommended Evolution

The following diagram summarizes the current IT management state and identifies recommended evolutionary changes which will improve the IT organization's ability to effectively manage IT investments:

Current IT Management Environment	Recommended Evolution
Planning and Delivery • IT Strategic Planning Committee • Prioritized list of work across organization • Data governance roles and accountabilities (Data Owners and Stewards) • Business case discipline for larger projects • Consistent project status reporting • Prioritize and fully staff "Big" programs • Clear business ownership for programs	**Enterprise Portfolio and Project Lifecycle Program** • Refine portfolio planning and management processes • Common project development methodology • Common PMO and Portfolio Planning responsibility • Resource Assessment and Co-ordination • Clear architecture, development and technology principles to be used for projects
IT Operations • Critical IT policies and processes being documented • Lock down end point authorizations and control • End point skills and expertize in house • Help desk application for capturing, closing and reporting service requests • Leverage external experts for technical support and advice • Role based authorizations in directory with single administration	**IT Foundations Program** • Evolve Vendor Management processes • Include smartphones and tablets in end point management process • Write DR plans that meet agreed to RTO (Return To Operations) and RPO (Restore Point Objectives) targets set by business. • Document SLAs • Implement Release Management for all major platforms and environments
	Organizational • Consolidate application, data and technology architecture accountability and staff in one team with lead architect. • Continue to grow or retain key application ownership/administrator roles internally • Roll out data governance accountabilities for all major areas • Continue to grow Business Analysis and Business Change Roles with certifications

Figure 8: IT Management Environment Evolution

Appendices

Appendix A: Program Charters

Appendix B: Cloud Computing

This appendix explains aspects of cloud computing, including the characteristics, models and types. Material for this document has been drawn from articles published by Cisco and IBM.

The term "cloud computing" has different connotations for IT professionals, depending upon their point of view and often their own products and offerings. As with all emerging areas, real-world deployments and customer success stories will generate a better understanding of the term. This discussion starts with the National Institute of Standards and Technology (NIST) definition:

> *"Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (for example, networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction."*

Characteristics of Cloud Computing

The following is a list of characteristics of a cloud-computing environment. Not all characteristics may be present in a specific cloud solution.

- Elasticity and Scalability

  Cloud computing gives you the ability to expand and reduce resources according to your specific service requirement. For example, you may need a large number of server resources for the duration of a specific task. You can then release these server resources after you complete your task.

- Pay-per-use

  You pay for cloud services only when you use them, either for the short term (for example, for CPU time) or for a longer duration (for example, for cloud-based storage or vault services).

- On Demand

  Because you invoke cloud services only when you need them, they are not permanent parts of your IT infrastructure—a significant advantage for cloud use as opposed to internal IT services. With cloud services there is no need to have dedicated resources waiting to be used, as is the case with internal services.

- Resiliency

  The resiliency of a cloud service offering can completely isolate the failure of server and storage resources from cloud users. Work is migrated to a different physical resource in the cloud with or without user awareness and intervention. This characteristic often makes cloud solutions attractive for fault tolerance and business continuity reasons.

- Multi-tenancy

  Public cloud services providers often can host the cloud services for multiple users within the same infrastructure. Server and storage isolation may be physical or virtual—depending upon the specific user requirements.

- Workload Movement

  This characteristic is related to resiliency and cost considerations. Here, cloud-computing providers can migrate workloads across servers—both inside the data center and across data centers (even in a different geographic area). This migration might be necessitated by cost (less expensive to run a workload in a data center in another country based on time of day or power requirements) or efficiency considerations (for example, network bandwidth). A third reason could be regulatory considerations for certain types of workloads.

Cloud computing involves shifting the bulk of the costs from a capital expenditure (CapEx) model – i.e. buying and installing servers, storage, networking, and related infrastructure - to an operating expense (OpEx) model, where you pay for usage of these types of resources.

Major Models in Cloud Computing

The following is an explanation of some popular models of cloud computing that are offered today as services.

Infrastructure as a Service (IaaS)

IaaS is a cloud computing offering in which a vendor provides users access to computing resources such as servers, storage, and networking. Organizations use their own platforms and applications within a service provider's infrastructure.

Key features:

- Instead of purchasing hardware outright, users pay for IaaS on demand.
- Infrastructure is scalable depending on processing and storage needs.
- Saves enterprises the costs of buying and maintaining their own hardware.
- Because data is on the cloud, there is no single point of failure.
- Enables the virtualization of administrative tasks, freeing up time for other work.

Platform as a service (PaaS)

PaaS is a cloud computing offering that provides users a cloud environment in which they can develop, manage, and deliver applications. In addition to storage and other computing resources, users are able to use a suite of prebuilt tools to develop, customize and test their own applications.

Key features:

- PaaS provides a platform with tools to test, develop, and host applications in the same environment.
- Enables organizations to focus on development without having to worry about underlying infrastructure.
- Providers manage security, operating systems, server software, and backups.
- Facilitates collaborative work even if teams work remotely.

Software as a Service (SaaS)

SaaS is a cloud computing offering that provides users with access to a vendor's cloud-based software. Users do not install applications on their local devices. Instead, the applications reside on a remote cloud network accessed through the web or an API. Through the application, users can store and analyze data and collaborate on projects.

Key features:

- SaaS vendors provide users with software and applications on a subscription model.
- Users do not have to manage, install, or upgrade software; SaaS providers manage this.
- Data is secure in the cloud; equipment failure does not result in loss of data.
- Use of resources can be scaled depending on service needs.
- Applications are accessible from almost any Internet-connected device, from virtually anywhere in the world.

A variation of SaaS is **Business Process as a Service** (BPaaS). This is a form of Business Process Outsourcing (BPO) which leverages cloud computing services to delivery entire, cohesive business processes – such as payroll, HR and customer care whereby the provider provides not just the application systems and infrastructure, but also the human expertise and labour. Along with the aim of "traditional" BPO to reduce labour costs, BPaaS provides the additional economies and efficiency of the cloud computing model.

Public, Private, Internal Clouds

So far, we have focused on cloud service providers whose data centers are external to the users of the service (businesses or individuals). These clouds are known as ***public clouds***; both the infrastructure and control of these clouds is with the service provider.

A variation on this scenario is the **private cloud.** Here, the cloud provider is responsible only for the infrastructure and not for the control. This setup is equivalent to a section of a shared data center being partitioned for the sole use by a specific customer. Note that the private cloud can offer SaaS, PaaS, or IaaS services, though IaaS might appear to be a more natural fit.

An **internal cloud** is a term sometimes applied to computing services provided by the IT department of an enterprise from the company's own data centers, using a cloud model. An example of this might be a corporation providing a virtualized computing environment which has the tools and processes in place to allow subsidiary organizations or departments to manage and administer their own computing needs. This setup might seem counterintuitive at first—why would a company run cloud services for its internal users when public clouds are available? Doesn't this setup negate the advantages of elasticity and scalability by moving this service to inside the enterprise?

This model can be very useful for enterprises. The biggest concerns for enterprises to move to an external cloud provider are security and control. CIOs are naturally cautious about moving their entire application infrastructure and data to an external cloud provider, especially when they have several person-years of investment in their applications and infrastructure as well as elaborate security safeguards around their data. However, the advantages of the cloud—resiliency, scalability, and workload migration—are useful to have in the company's own data centers. IT can use resource-based billing to monitor individual business unit or department usage of the IT resources and charge them back. Controlling server sprawl through virtualization and moving workloads to geographies and locations in the world with lower power and infrastructure costs are of value in a cloud-computing environment. Internal clouds can provide all these benefits.

The NIST definition considers a private cloud to be the same as an internal cloud, however they are distinct in the that the private cloud, while administered and controlled by the user, is still hosted by a third party whereas the internal cloud infrastructure is operated by the enterprise to which the subscribing department or business unit belongs.

Hybrid Cloud

A **hybrid cloud** is any combination of dedicated data center services, public cloud services or private cloud services where one or several touch points exist between the environments. The goal is to combine services and data from a variety of computing models to create a unified, automated, and well-managed computing environment.

Combining public services with private clouds and the data center as a hybrid is the new definition of corporate computing. Not all companies that use some public and some private services have a hybrid cloud. Rather, a hybrid cloud is an environment where the private and public services are used together to create value.

An example of a hybrid cloud solution would be combining web application services, hosted on Microsoft Azure with SaaS services, hosted in a SalesForce.com private cloud with integrated Active Directory authentication and authorization, provided from a dedicated, internal data center. While the components of the solution are hosted in different infrastructures, by different service providers, using different service models, the end-to-end solution appears and behaves seamlessly for the end-user.

Hybrid solutions can be particularly useful in managing data and analytic services, largely due to the ability to scale capacity to demand for computing and storage resources, while collecting time series data from corporate and operational systems.

Hybrid cloud solutions can provide considerable business value however they require careful planning and management to be effective.

IBM offers a complimentary e-book entitled “Hybrid Cloud for Dummies” which can be downloaded by following the link in the References, below. This book explains hybrid cloud in more detail and provides an excellent and concise discussion of the issues around planning, managing, application development, integration, deployment and business impact.

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Appendix C: Glossary of Terms

The following is a brief explanation of the acronyms and system names used in the report:

- **AMI** – Advanced Metering Infrastructure. This refers to an integrated system of smart meters, communications networks, and data management systems that enables two-way communication between utilities and customers.
- **Cayenta** – This system includes a suite of application modules, including billing, CRM, workflow management and mobile workforce management. Halifax Water only uses the CRM module.
- **CityWorks** – a software system which provides a comprehensive set of GIS-enabled applications for asset, work and property management.
- **GIS** – Geographical Information Systems are those designed to capture, store, manipulate, analyze, manage, and present all types of geographical data.
- **HRM** – Halifax Regional Municipality
- **OMMS** - Operational Maintenance Management System (sometimes simply "OMM") is an application in the Cityworks suite which provides technology and processes to deliver better operational-level information with a focus on work order management. Also referred to as a Computerized Maintenance Management System (CMMS)
- **OSI PI** – System software developed by OSISoft which enables the collection, analysis, visualization and sharing of large amounts of time-series data from multiple sources.
- **PNS** – Province of Nova Scotia
- **SAP** - Systems Applications and Products in Data Processing (both an application product and a company name)
- **SAP CSS** – Part of SAP's IS-U suite – Customer Care and Services
- **SAP IS-U** – SAP's Industry-specific Solutions for Utilities
- **SAP S4** – Also referred to as SAP S/4HANA. This is a major enhancement to SAP's Enterprise Resource Planning (ERP) platform.