ND State Water Commission

IT Strategic Plan

2015-2017 Biennium

Submitted By:

Christopher D. Bader

IT Coordinator

(701) 328-4771

cbader@nd.gov

ND State Water Commission IT Strategic Plan (2015-2017)

IT Architecture Review

The State Water Commission (SWC) is responsible for the management and regulation of the water resources in the State of North Dakota. The mission of the agency and the State Engineer . .

> *. . . is to improve the quality of life and strengthen the economy of North Dakota by managing the water resources of the state for the benefit of its people . . .*

The SWC utilizes information technology to support almost all facets of the business operations surrounding water resource management. Agency IT requirements are generally driven by the scientific applications used for water resource analysis. Advanced data analysis, research, data modeling, and engineering applications are routinely combined with customized applications that are developed internally. Because of the wide range and diversity of applications used, the IT infrastructure must be open and extensible. An open framework supports a wide range of diverse applications, which makes it possible to easily scale and evolve the IT infrastructure to accommodate changes in current initiatives as well as any new initiatives.

Currently, the SWC has implemented a collection of services and solutions that are based on a range of open source and commercial application development solutions. The core of the SWC's infrastructure is based upon 4D's data management / application environment. 4D provides a unique application development environment integrated with a robust data management engine. In an effort to address the spatial aspects of the water resource systems that are managed by the SWC, significant effort has been made over the past ten years to integrate GIS and related mapping services. Most of these services are based upon open source solutions, which provide extensible resources that can be easily integrated with other tools available within the scientific and engineering disciplines.

The SWC maintains the following line of business applications:

Well Inventory – provides data management functions for the collection and analysis of the data supporting the management of North Dakota's ground and surface water systems. There are currently more than 35,000 sites for which data has been collected throughout North Dakota. This system includes subsurface information for nearly 26,000 of these sites with nearly 4.8 million water level observations and more than 68,000 water chemistry samples. This system also houses the domestic log reports filed by private well drillers for more than 58,000 sites throughout North Dakota.

Water Permits –provides management functions for North Dakota's water appropriations. It includes all of the necessary legal information related to requested and approved water appropriations as well as related historic water use reporting. This system also includes management functions for all temporary water permits that are processed in North Dakota, as well as custom monitoring functions for Water Depots that supply water to the oil industry.

Retention Structures –provides management and reporting capabilities for all of the major water retention structures in North Dakota. This includes Dams, Dikes, Diversion Structures, Dugouts, and other types of retentions structures. This system also includes an inventory of the majority of legal drains in North Dakota. In addition to the structures and drains, management functions related to construction permits in North Dakota as they pertain to the construction of water retention structures are also included.

Precipitation Stations –provides management for the network of private observers that report precipitation information throughout North Dakota. This network is maintained by the Atmospheric Resource division of the SWC and represents one of the largest and most comprehensive observer networks in the US. This system includes station information, daily precipitation values, and observed occurrence of hail events.

Flight Operations –provides support for the cloud seeding operations performed by the Atmospheric Resources Division. This includes flight tracking, inventory tracking for designated chemicals, and other related functions that pertain to the field operations that are conducted June through September.

Survey System – provides internal management for North Dakota's survey benchmarks. In addition, it provides a self-service utility for the Survey community to access North Dakota's survey repository, GLO's, and relevant benchmark data.

Lidar Dissemination System – provides internal management for all of the various Lidar data collection efforts in North Dakota. In addition, it provides a self-service utility for the Survey/Engineering community to access North Dakota's Lidar repository. All of the data can be easily selected and made available for download through a simple map service.

While 4D is a cross-platform system and will run on either Macintosh or Windows platforms, the implementation of 4D and the backend open source systems are uniquely designed to work with the Unix environment provided on the Macintosh platform. The Unix platform provides greater utility to integrate a variety of tools that are available for water resource management.

All of the business applications in use at the SWC were designed, developed, and maintained by internal staff. Most of the development at the SWC revolves around scientific application requirements. As a result, it is very difficult to assign these types of tasks to traditional IT programmers. The SWC currently maintains two staff positions within the IT section to develop and support the agency application base. One position is classified as a Hydrologist, and the individual within this position has training in hydrology and meteorology. The second position carries the Information Technology Administrator classification, and the individual within this position has training in geology, geohydrology, and geography. In addition to the core

application services, other staff members in the agency also contribute to the development of some of the more focused tools that surround the primary business applications. While these positions do not contribute any time to the core business applications that are in service, the tools that they provide do augment the business applications to address analysis needs unique to specific water resource management functions.

IT Asset Management

The State Water Commission (SWC) currently maintains IT infrastructure to support 95 FTE's. This infrastructure includes the necessary technology to serve the desktop needs as well as the server, storage, and back-office needs for most of the SWC business functions. In addition to the standard office automation peripherals such as printers and photocopiers, the SWC also maintains large format plotters and printers as well as large format scanners to address agency business requirements.

The SWC currently supports all development, maintenance, and procurement functions with internal staff. The SWC maintains 4 FTE's for purposes of supporting the IT infrastructure and related data management and data development functions required by the agency. While all four positions provide some support for the agency data management infrastructure, only one FTE is dedicated to provide help desk and related maintenance, procurement and desktop deployment functions. The other 3 FTE's provide some indirect support, but for the most part are focused on data management, data development, and program development related functions in direct support of the agency data management requirements.

In order to provide the necessary tool base to address the various aspects of the agency business model, it is necessary to maintain an IT infrastructure that is relatively current. This includes maintenance, management, and replacement of much of the IT infrastructure on an on-going basis. The current IT asset management plan in place at the SWC varies depending upon the type of IT equipment. In order to maintain the IT infrastructure so that it all works together and continues to meet the on-going needs of the agency, replacement schedules have been developed for much of the technology deployed at the SWC. Different replacement schedules have been developed for the different classes of equipment to provide more efficient utilization of the limited resources. Each of the major categories will be discussed separately.

Desktops

For the past 20 years, the SWC has maintained a mixed platform shop with both Windows and Macintosh users, and a small number of Linux workstations. In 2006, Apple introduced its first Intel based Mac, and in 2007, Apple migrated its entire product line to the Intel architecture. This provided an opportunity to standardize the SWC desktop hardware on a single architecture that would support all of the different OS requirements for agency users. This hardware independence has improved the efficiency of desktop deployment and replacement. Because the Apple Macintosh computer will run MacOSX, Windows, and Linux natively, the SWC can now purchase hardware without regard to the OS requirements of individual users. More importantly, as we migrate the existing hardware within the agency, there are no longer any hardware barriers to prevent the utilization of the technology anywhere within the agency.

Currently, the SWC has standardized on the Macintosh Desktop computer with Apple's Mac OSX as the base operating system. Through virtualization any other OS can be run with minimal performance penalties. Windows and Linux distributions can be created and then deployed simply by dragging disk images across the network.

The SWC has a range of desktop system requirements, which includes everything from an office automation workstation deployment to very high-end computational modeling workstations. The standard 4 year replacement cycle advocated by EA does not work well for the more advanced scientific requirements where end-user needs are better served with a much more aggressive replacement cycle. However, at the other end, user demands at the office automation stations are generally much lower and can be upgraded less frequently. As a result, the SWC has adopted an upgrade policy where the advanced high-end workstations are generally replaced every 2 to 3 years. The displaced machine is then migrated down within the user hierarchy to users with lower requirements. The net effect is that the desktop fleet in general adheres to a 4-year replacement cycle.

In addition to the standard desktop users, the SWC has many users that require mobile computing. While in the past the SWC provided shared laptops to address mobile user requirements, better mobile technology combined with better tools to integrate laptops within the desktop environment has changed the approach toward mobile technology. Currently, the SWC maintains a small pool of laptops that are available to the occasional mobile user. The SWC has also replaced standard desktop configurations with laptops and docking stations for routine mobile users.

The SWC currently maintains 85 desktop computers. The agency also supports 10 laptop computers that are used as the primary machine for staff with mobile requirements. In addition, 6 laptop computers are maintained for purposes of addressing the mobile requirement for the remainder of the staff with occasional mobile requirements. In the future, it is likely that additional desktops will be converted to combination laptop / docking stations. However, this will be impacted in large part by the mobile strategy that evolves, which will depend to some extent upon the versatility provided by newer mobile platforms like Apple's new iPad.

Mobile Platforms

As mobile technology becomes more versatile and capable, mobile platforms will continue to gain focus at the SWC. A significant number of SWC employees have mobile technology requirements, which includes not only traditional connectivity requirements for attending meetings and conferences but also remote field operations. With the inclusion of GPS, handheld platforms are now capable of providing fully functional GPS/GIS workstations for remote field operations that was cumbersome to achieve with a more traditional laptop form factor. As connectivity throughout rural North Dakota continues to improve, these platforms can also provide direct access to much of the mapping and data management infrastructure that is currently used to support the agency data management operations.

While tablets and smart phones may provide the necessary functionality to eliminate the need for some laptops, many of the functions for which the SWC will deploy these platforms represent new applications and will require on-going funding to support. One interesting aspect of smartphones and tablets is that in many cases, employees prefer to provide and use their own personal device. This is due in large part to the role that these devices play as they provide a means of integrating employee personal and professional schedules.

When you combine the functionality of these devices the degree to which they provide necessary integration between back-office systems, field operations, and employees personal schedules, the challenge facing the SWC is not whether or not to deploy mobile systems, but how to effectively manage the combination and integration of both state owned devices and personal devices in a manner that supports the agency's mobile operational requirements.

Monitors

Desktop monitors in use by the SWC have evolved over the years from a CRT based technology to flat panel technology. Currently, there are no CRT monitors in service at the SWC. In addition, Apple's iMac platform includes an integrated monitor, which means that monitor replacement is tied to the desktop system. For the laptop workstations where an external monitor is required and for other installations where a stand-alone monitor is required, the SWC has adopted a replacement strategy for monitors more closely tied to the life-cycle of the monitors. Based upon the life-cycles that have been experienced with the flat-panel display technology, monitors are targeted for replacement between 5 and 6 years.

Printers / Copiers / Plotters / Scanners

Historically, the SWC maintained an array of network business printers, photocopiers, high-end color printers, large format plotters, and a few inkjet color printers. Printing technology has evolved significantly over the past decade, and the SWC has consolidated the majority of the agency print services around two high-speed digital photocopiers. Both digital photocopiers were upgraded at the end of the 2011-2013 biennium to include color, which has provided the opportunity for the agency to eliminate stand-alone color printers that were maintained prior to their introduction. The agency still maintains three workgroup printers that are available in key areas for purposes of addressing specific print functions that can't be addressed through the digital photocopiers.

With the integration of high-speed print services, the color digital photocopiers have replaced the functionality of more than 9 printers that were on the network prior to their introduction. Replacement cycles on these will be dictated by equipment duty-cycles, which based upon the current digital copier technology appears to be between 6 and 8 years.

In addition to the general-purpose business printing requirements, the SWC will continue to require large format printing capabilities. These are currently being met with a large format HP DesignJet printer. The replacement cycle for this device will be dictated by the life-cycle of the printer which is somewhat governed by it's use. Based upon current usage, it would be reasonable to assume that the replacement cycle for this device will continue to range from 6 to 8 years.

Over the past three years, the SWC has been moving much of the agency paper records into digital form for purposes of access, preservation, and long-term archival. As a result, agency document workflow has changed somewhat to accommodate capture and digital conversion of existing paper records and incoming paper records. This has necessitated an increase in scanning capabilities to include desktop scanning solutions for several users. Providing desktop scanning solutions is the only real effective way to address digitizing the documents within the current workflow environment. The SWC currently maintains 13 desktop scanners with duplex and OCR capabilities, and it is anticipated that an additional scanners will be added over the next biennium. The life-cycle of these scanners will likely be dictated by the workload and will vary from station to station depending upon the volume of scanning performed at each station. However, based upon industry claims, it is anticipated that the replacement cycle for the desktop scanners will be between 3 to 4 years.

In addition to the many desktop scanners used in conjunction with records management, the SWC also maintains a large-format scanner for purposes of scanning large maps, plats, and plans. The replacement cycle for the large format scanners will be dictated by life-cycle which appears to be in the range of between 6 and 8 years. Both of the digital photocopiers provide scanning options, but the replacement cycle for these is tied to the replacement cycles for the photocopiers. Currently, the digital photocopiers also provide integrated OCR capabilities, and this will reduced the need somewhat for scanning technology to be placed on the desktop.

Servers

The SWC maintains the server infrastructure to support the agency data management and application requirements. Unlike the desktops, monitors, and other peripherals, server replacement cycles are more often dictated by application and software resource requirements than by equipment life-cycles. It is not uncommon to upgrade or implement software changes that will vastly change the load and demand placed upon the server. Because server performance and reliability impact the productivity of all SWC employees, replacement cycles are matched to the functions that the server provides. The agency database-application servers require greater performance with greater RAM requirements. These servers are generally replaced more frequently with an average replacement cycle of between 2-3 years. Typically, the displaced servers are then re-conditioned to replace the role of the file server, web server, or other servers with minimal performance requirements. As a result the replacement cycle on average for all of the servers is between 3 and 4 years.

Storage

In addition to the storage that is attached to each desktop, laptop, and server, the SWC also maintains server based storage used both as primary server storage and backup storage. The storage infrastructure currently in service at the SWC consists of direct attached, and NAS based storage infrastructure. With the overwhelming growth in storage requirements to address both the digital capture of the historic image resources and on-going management initiatives to collect image data and digital aerial photography, the SWC makes every attempt to balance the storage solution with the needs of the targeted data.

The storage is maintained and managed independent of the server infrastructure, and as such, a replacement strategy has been developed that requires replacement of the disk and related subsystems every 6 years. Given the constant increases in storage density, this replacement strategy is expected to provide the necessary replacement of aging infrastructure as well as increased storage capacity to meet on-going increases in storage demands.

Software

The SWC maintains a policy to keep all software current. Over the years it has been determined that routine incremental upgrades are far less traumatic on the day-to-day business model than larger periodic wholesale updates. Given the mix of software tools that are used within the agency, this includes an array of different schedules and software maintenance issues. For many of the larger applications and software suites the agency is enrolled in annual maintenance to maintain the current state of the software. This includes ESRI's GIS software suite, Microsoft Office, ERDAS, Groundwater Vistas, AutoCad, and 4D. For software without pre-defined maintenance plans, the software is routinely upgraded as upgrades become available. Generally, this ranges from 12-month intervals to 24-month intervals.

Staff Retention and Recruitment

Recruiting and maintaining qualified IT staff is difficult in an environment where you have little control over salary structures. This is even more relevant today when industry demand for IT professionals is increasing. When comparing IT salaries for SWC IT staff with the 2013 edition of Wages for North Dakota Jobs (published by Job Service North Dakota) for similar positions in the Bismarck-Mandan area, the SWC IT salaries are reasonably competitive within the region.

While salary is a very important factor that contributes to effective recruitment and staff retention, it is not the only factor that drives IT professionals. The SWC has been very fortunate to recruit and maintain a qualified IT staff. This can be attributed to a large degree to the type of infrastructure that is maintained at the SWC and the management structure that has been implemented. The SWC maintains an environment where the individual IT staff have considerable latitude with direct involvement with the development and deployment of IT solutions end-to-end. This provides the ability for the staff to learn and grow within their position. In the end, this type of latitude provides a better work environment for the IT staff and yields significant benefits to the agency as more innovative solutions are allowed to be developed and implemented.

Operational Infrastructure

In 1999, the SWC developed a needs assessment that addressed the scientific and engineering requirements for the agency as it moved forward. This needs assessment ultimately provided the foundation for the current infrastructure. Within this assessment, the framework that was defined identified significant investments that would be required in the IT infrastructure, if the agency was to continue to meet it's water resource management obligation in the future.

During the 01-03 and the 03-05 biennia, the SWC's IT infrastructure was completely re-engineered to provide a framework for the agency to develop the necessary tool base to meet the challenges that the agency would face over the next two decades and beyond. During the 05-07 biennium, additional components of the infrastructure framework were completed and significant work was completed to integrate and extend much of the IT infrastructure to address many of the key scientific functions required for water resource management. At the end of the 05-07 biennium and during the first half of the 07-09 biennium, the SWC successfully completed the migration of the desktop fleet to a single platform that provided better uniformity and consistency to support the daily work requirements and better support for back-end resources like computational clustering. During the 09-11 biennium, management solutions were effectively deployed to address system imaging and other resources to reduce the administrative overhead associated with deployment, maintenance, and support of the desktop infrastructure.

As the agency moves forward, there are five key areas that will require ongoing attention. These include Data Management, GIS services, Computational Clustering capabilities, Storage Management, and Mobile Computing.

Data Management

Data collection is an integral part of many of the SWC's on-going water resource management operations. Water resource data pertaining to water levels, water chemistry, and well information is collected for purposes of monitoring impacts to North Dakota's ground and surface water resources. This includes on-site data collection by agency field staff and private contractors and continuous collection efforts using electronic methods. The SWC also collects real-time data for radar and flight operations for the North Dakota's weather modification and hail suppression program. GPS technology is used to collect real-time data within many of the flight operations. GPS technology is also used to generate the necessary survey base for construction projects and many other site-specific projects requiring spatial reference information.

The SWC maintains cooperative reporting programs for purposes of collecting water use information, private domestic drilling information, and observed precipitation information. In addition, the SWC is involved with a variety of data collection efforts to obtain site specific information relevant to water permits, dams, drains, wetlands, and other construction projects that pertain to water diversion or retention. The SWC also routinely collects and processes aerial photography for many areas where there has been significant irrigation development for purposes of monitoring irrigation, evapotranspiration, and other parameters relevant to water resource management.

The SWC has implemented a wide range of technology solutions to accommodate the data collection programs. The SWC uses electronic monitoring tools in many of the data collection programs in an effort to provide more accurate data and to reduce overall cost associated with data collection. In addition, technology has also been implemented where practical in the form of hand-held devices and laptops to facilitate field entry and eliminate re-entry into back office systems.

With the continual evolution of remote telemetry technology, more and more options are becoming available and are sufficiently cost effective to begin using remote telemetry options for many of the data collection efforts. Telephony solutions are currently being evaluated to provide remote connectivity to many of the recorder stations that are currently used to collect near real-time water level measurements. Most of these recorder sites are currently accessed monthly or quarterly, and the data is recovered manually via handheld or laptops in the field. The Water Commission has targeted as many as 70 recorder sites for the installation of remote telephony to provide access to the data in real time. This could lead to significant savings in terms of physical resources required to visit these sites to recover the data. If successful, the implementation of the remote telemetry could well be extended to many of the Water Permits throughout the state as well as a number of additional continuous recorder sites.

The data management infrastructure currently maintained by the SWC is based upon distributed client-server architecture. Given the diverse types of data collected combined with the broad range of analysis requirements, the SWC has expended considerable effort to establish an open and extensible management infrastructure that will support different types of data and the associated collection, management, and analysis efforts. This infrastructure currently supports industry connectivity standards, including ODBC, JDBC, XML, Web Services, Oracle OCI, and many others. At this point, the SWC can push or pull data to almost any commercial software that

uses standard communications protocols, and all of the data collected by the SWC is available for public access over the web.

GIS Services

As part of the needs assessment that was developed in 1999, the SWC identified the role that GIS would play in the development of future water management resources. This assessment clearly identified the size and scope of the infrastructure required to provide the necessary GIS resources. Given the size of the user base that would be served at the SWC, it was not cost effective for the SWC to develop core components of this infrastructure internally. Therefore, recommendations were made for ITD to provide these core components of the infrastructure so that they could be extended to a larger user base. The SWC worked closely with ITD to develop the strategic funding requirements necessary to provide the state with a shared GIS infrastructure capable of delivering base GIS services for the state government users. The SWC has also been instrumental in the data development and implementation of the state GIS hub.

Moving forward, the GIS Hub continues to play less of a role for the SWC's GIS initiative. This is due in part to the costs associated with deploying ESRI infrastructure and also to the inability of ITD to develop and provide services for non-ESRI solutions. The majority of tools and management functions required for water resource management are designed and built internally in order for these services to support water resource management. While the agency obtained funding to deploy some initial resources using ESRI's base infrastructure, both the ESRI cost model and limitations with ESRI's support model for open industry standards made it difficult to build the necessary infrastructure around the ESRI model. As a result, selected open source alternatives were evaluated and deployed through the 2005-2007 biennium. The open source solutions selected were capable of being deployed on existing hardware infrastructure and supported the same industry connectivity standards as the existing SWC data management infrastructure. This provided significant opportunities to develop integrated data management solutions and more comprehensive data analysis solutions that better meet the needs of the SWC. In addition, the open source solutions also provided significant cost savings related to deployment as well as on-going cost savings for maintenance.

The majority of the GIS infrastructure required to provide the necessary services for the SWC is currently in place and is integrated within the current management infrastructure. Moving into the 2009-2011 biennium, the SWC completed many of the base service tools that provide the foundation for future water resource management efforts. Over the coming biennium, work will focus more on the analysis and related water resource management tools to support the management initiatives required of the agency.

Computational Services

Increasing demands for more comprehensive analysis of surface, subsurface, and atmospheric systems has required the agency to develop and implement more sophisticated computational resources. Currently, the agency uses a variety of modeling tools available from the US Geological Survey, US Bureau of Reclamation, the US Army Corps of Engineers, and other sources. These tools are used to provide

insight into the environmental and geologic characteristics of these systems so that the agency can develop better understanding of the respective systems.

While many of these tools have been available for some time, the application of these tools has evolved in recent years and utilization of these tools now demand far more resources to achieve useful results. In most cases, the model requirements exceed the computational capabilities available on a single desktop or server. The current server base that has been deployed provides tools capable of addressing the computational requirements for the next generation of ground water, soil profile, surface water, and atmospheric models. Parallel processing technology can also be extended beyond the server core to include the agency desktop workstations. This capability has allowed the agency to leverage not only the server core, but also all of the agency desktops to extend the computational resources as needs grow and evolve. Because of the nature and extensibility of the core IT infrastructure, the SWC has developed and will continue to grow and evolve super-computer class computational resources for little or no cost.

Storage Management

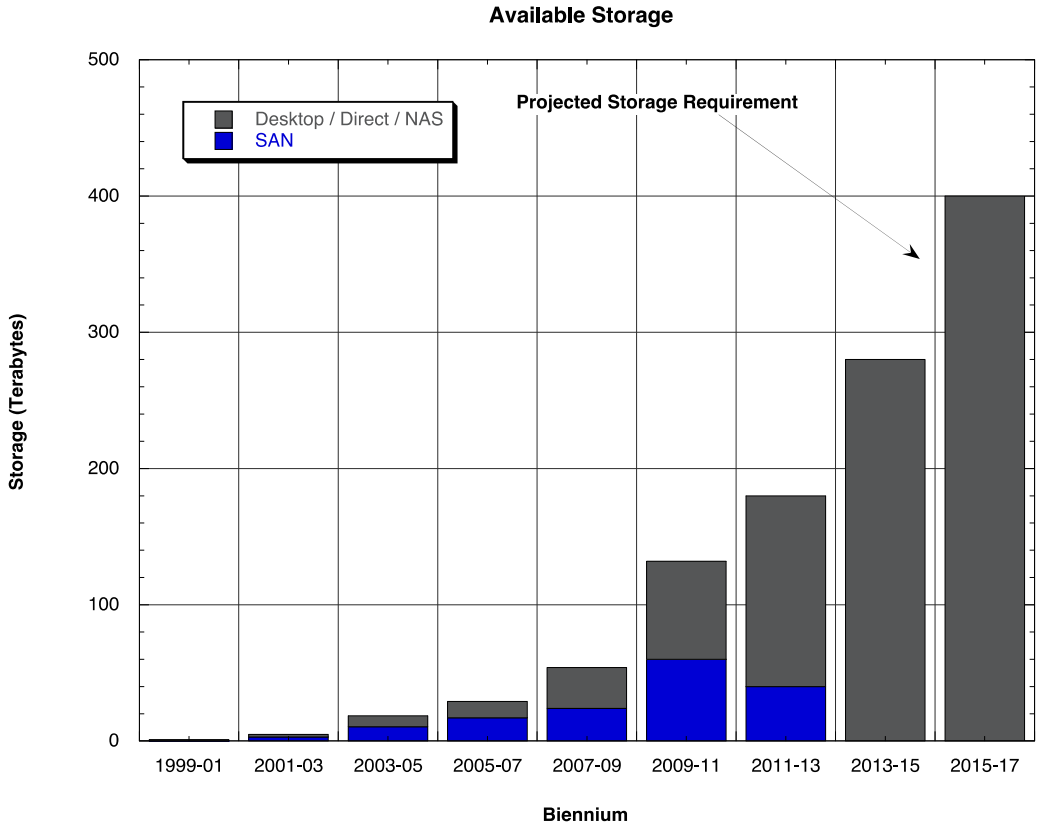
The SWC is responsible for many paper data resources for which there are no duplicates. This includes the General Land Office (GLO) survey plats, Survey Notes, Water Permits, Drillers Logs, Project Records, and many other resources. Historically, these resources existed in paper form and there are no backup copies available, and many have deteriorated with age. In order to preserve and maintain these data resources, the SWC has digitized many of these resources to provide digital copies to be used in-house and to provide a means of storing copies off-site for disaster recovery purposes. In addition, most of these resources have also been made readily available to the general public through the Internet.

Over the past forty years, the SWC has collected aerial imagery and other remotely sensed data of many areas where irrigation development is growing and in areas where there has been flooding or flooding concerns. This imagery is an invaluable resource for determining and documenting hydrologic conditions relevant to specific events. Historically, this imagery was maintained in paper form. However, with improvements in GIS and image technology, this data can now be used within GIS to provide better utilization of the data. The SWC has completed the digitization of the image resources that are available within the agency, and now efforts are focused on the conversion of these resources into spatially enabled products so that they can easily be used within a GIS framework. Most of these types of data are currently collected in digital form and all future data collection for aerial imagery, Lidar, as well as many other forms of direct and remotely sensed data is collected and disseminated in digital form.

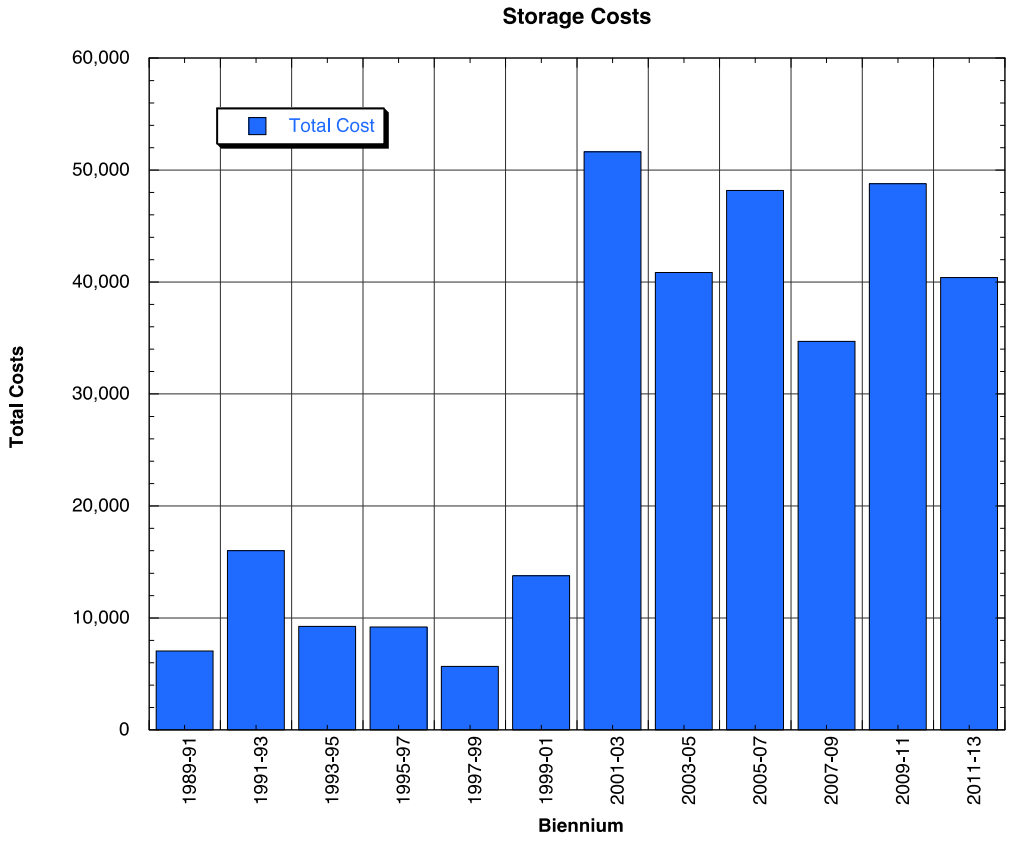
In addition to digitizing many of the historic paper records and the on-going data collection efforts surrounding imagery and Lidar, the SWC has also increased the volume of data that has traditionally been collected for water resource monitoring through the use of continuous recorders and other means. This has resulted in significant increases in the volume of data that is collected and maintained by the SWC. As a result, storage is now the single biggest challenge facing the SWC to provide the necessary data infrastructure capable of meeting the agency's water resource management requirements.

In 2002, the SWC maintained approximately 1 TB of active disk. This included both desktop direct attached storage as well as direct attached storage on the agency servers. In order to accommodate increasing storage requirements, the storage infrastructure for the SWC was completely re-engineered during the 2001-2003 biennium to include a SAN storage solution. It was necessary to provide storage services independent of the server resources so that available storage could easily be increased as needs dictated. By separating storage and servers, the storage services could also be used more efficiently across the entire server base. The storage infrastructure that was implemented accommodated the storage requirements for the SWC and provided a means of controlling storage costs to levels that did not dramatically exceed standard desktop storage costs.

Since the introduction of the SAN storage solution in 2001-2003, the SWC has added additional storage to accommodate the storage requirements associated with many of the initiatives outlined earlier. By 2010, the SWC SAN had reached an effective capacity of 60 TB. However, with the introduction of cheaper direct attached RAID storage solutions, the SWC has been able to eliminate SAN based storage in favor of these more cost effective direct attached RAID solutions. The SWC currently maintains more than 160 TB of direct attached storage in the primary data center and this does not include embedded desktop storage within the agency desktop computers. In addition, the SWC maintains approximately 200 TB of storage in the remote data center for purposes of backup and disaster recovery. Looking forward, SWC storage requirements have been projected to approach 400 TB over the next three years through the end of the 2015-17 biennium.



With this type of growth in demand for storage, it would be reasonable to assume a similar increase in storage costs. However, agency expenditures for storage do not demonstrate the same dramatic increases, as the following graph clearly demonstrates. Generally, storage costs for the SWC remained fairly flat until the 2001-03 biennium, which marked the introduction of the SAN infrastructure. Since the deployment of the SAN infrastructure, storage costs have again stabilized at a fairly flat rate, albeit a much higher base cost than the pre-SAN infrastructure. Differences in these base costs are clearly a direct result of the class of storage infrastructure that has been deployed and the continued growth in demand for storage.



The SWC has been successful at controlling storage costs while increasing available storage capacity primarily because of increases in storage density. The current replacement cycle for most of the SAN infrastructure provided significant opportunities to expand available storage as disk arrays were replaced for maintenance purposes. In addition to increasing storage density, the SWC has also tailored the appropriate storage solutions for each respective task. Costs for SAN infrastructure are considerably higher than costs associated with direct attached storage solutions. Since SAN infrastructure is generally not necessary for some project level work and data archival, the SWC has been able to integrate non-SAN solutions using direct attached and NAS storage solutions where appropriate. Given the nature of much of the data and costs associated with the SAN infrastructure, the agency has been able to move entirely away from SAN based storage providing

opportunities to implement more cost effective storage options to address the growing demands for storage with only minor increases in the base budget.

Mobile Computing

With the introduction of Apple's iPad, mobile technology has evolved to the point where connectivity, screen real estate, and functionality provide sufficient capabilities to provide viable tools in the field. The Water Commission is currently utilizing these mobile platforms in a variety of roles ranging from field work where effective GPS mapping capabilities are required to mobile users that simply require connectivity and data services while in the field or on the road.

Beyond the laptop computers assigned to individuals and the laptop pool available for users with an occasional mobile requirement, the SWC currently has not deployed significant mobile resources. This is not because the SWC does not have a need for mobile computing, but more because mobile computing capabilities that were available did not provide an effective platform to fit our mobile needs. There are two criteria that are critical to the effective deployment of mobile technology for the SWC, which include connectivity and screen real estate. With the advent of smart phones and the improved cell coverage throughout North Dakota, the issue of connectivity has now been addressed. While smart phones can provide a viable platform for business applications such as e-mail and occasional web browsing, they lack sufficient screen real estate to be effective mapping tools in the field.

With the recent introduction of Apple's iPad, mobile technology has finally evolving to the point where both the connectivity and the screen real estate are sufficient to provide viable tools for field use. These devices can now provide access in the field to many of the backend data systems to retrieve data and validate data collection efforts while in the field. With the increased screen real estate, they now provide capabilities to display maps and other image data while in the field, which proved somewhat difficult on the smaller form factor of the smart phone. At this point, the SWC has already started deploying these types of mobile platforms with field personnel during the current biennium. Ultimately, we will see significant growth in this area as the technology and connectivity continue to evolve.

Currently, these mobile solutions are filling a major need for which no technology was previously available. Because of the nature of the field work where the agency anticipates deployment of these types of devices, it is unlikely that these devices will be purchased in lieu of a laptop or other more expensive device. As a result, the agency will not experience cost savings by purchasing tablet devices as they are not replacing other technology solutions. In the end, to properly deploy the mobile solutions the SWC increased the base IT budget during the 2011-13 biennieum and this base level of funding will need to be maintained.

Future Challenges

The SWC has developed an IT infrastructure that is tailored to address the complex data management and data analysis functions associated with Water Resource management. The data infrastructure and related data resources that are currently in place reflect more than twenty five years of on-going active development. When

comparing North Dakota's data management infrastructure and related data resources with any other state in the US, North Dakota provides one of the most complete and capable infrastructures in the country.

Ironically, the single biggest threat facing the SWC moving forward is not technology or lack of funding, it is the propensity of the legislature to micro-manage IT in state government. Even though the legislature was responsible for the enactment of the current laws requiring the development of the strategic planning process, these plans are apparently not referenced when evaluating IT within state government. The success of the current IT infrastructure that is in place at the SWC represents the results of an on-going effort on the part of the agency to develop an IT strategy that best addresses the complex scientific requirements associated with managing ground and surface water resources. This strategy is routinely modified to accommodate changing technology and improvements in the spatial tools and related resources. Currently, the SWC maintains an IT infrastructure that is far more cost effective than anything that can be maintained at ITD and effectively addresses the needs of the agency.

The legislature recently tasked the UmmelGroup to develop a study to evaluate consolidation for the SWC and three other agencies, which has resulted in a recommendation by UmmelGroup for full consolidation. Even though the SWC has spent years in the planning and development of the technology infrastructure required to address water resource management, the UmmelGroup spent all of four (4) hours with the SWC and determined that consolidation was not only appropriate but in the best interests of the state of North Dakota. The UmmelGroup did a very poor job of assessing total costs associated with the consolidation. They also ignored key technology differences that exist between the IT infrastructure currently supported by the SWC and that supported by ITD. Even though the recommendations presented by the UmmelGroup are poorly founded and incomplete, it is likely that the legislature will proceed forward with full consolidation for the SWC and the other agencies. Appendix A includes a more detailed review the UmmelGroup recommendations and provides a more realistic cost estimate of the consolidation costs than those presented by the UmmelGroup.

While the analysis presented in Appendix A provides a more accurate presentation of costs associated with consolidation, it does not address many of the intangible costs associated with this endeavor. It is entirely likely that if this is to proceed, that the SWC will spend the entire 2015-2017 biennium working with ITD to achieve the consolidation target. This means that the SWC will not be able to further develop the remote telemetry, data management, and the many analysis tools that are currently targeted for development and deployment during this time frame. There will be additional costs associated with down time and the redirection of staff to achieve the goal of consolidation rather than the goal of continued development of the tools and resources required to achieve the agency mission.

The results defined in Appendix A represent a best case scenario because they are based upon assumptions that UmmelGroup made regarding the way that ITD will provide the virtualized services, which includes providing full administrative control to the agency. Currently, ITD does not provide virtual services as prescribed by UmmelGroup, and should they choose not to pursue this class of service, costs, delays, and downtime for the SWC will grow dramatically. While the analysis presented in Appendix A, presents a total consolidation costs approaching $2.5 million dollars, these costs could easily exceed $8 million if ITD does not provide the level of service and the flexibility prescribed by UmmelGroup.

The SWC is currently in the middle of an unprecedented demand for water resources for both oil industry related uses and increasing agricultural uses. Currently, the technology infrastructure is meeting these demands and providing opportunities for the SWC to extend the utility and capability of current staff to address these unprecedented demands. It would not seem prudent to make the types of changes that are prescribed by the UmmelGroup in the middle of the demands that the oil and agriculture are currently placing on water resource management in North Dakota. If the recommendations of the UmmelGroup are inacted by the legislature, then any planning that has been prepared for the on-going development of the IT infrastructure for the SWC will become irrelevant. The bottom line is that any plans that currently exist related to the IT infrastructure for the SWC will require a complete re-assessment.

Appendix A – Impacts of Consolidation

Senate Bill 2021 included provisions for OMB to conduct an information technology relocation and consolidation study of information technology equipment operated by the attorney general and by agencies currently exempted by OMB. This study was directed to consider cost, physical security, cybersecurity, redundancy, staffing, impact on service to stakeholders, and impact on contractual relationships for software and hardware with federal partnerships.

Background

The recommendations that were prepared by the UmmelGroup for the Water Commission were based upon less than 5 hours of staff interviews and a copy of the most recent agency strategic plan that was prepared more than two years ago. The UmmelGroup did not request any financial data nor did they request any details related to the breakdown of current budgets that were allocated to the relevant server infrastructure. While additional meetings were scheduled with the UmmelGroup to address many of the scientific areas, there were no additional meetings because the UmmelGroup either cancelled or simply did not show up. As a result, the recommendations presented by the UmmelGroup were based upon an incomplete picture of the IT infrastructure that is currently in place at the Water Commission and a lack of understanding of the business model that this infrastructure was designed to address.

In addition to a number of erroneous and unfounded assumptions, the UmmelGroup study draws a number of conclusions that simply have no basis in reality. Therefore, the recommendations and any related projections related to budget, costs or benefits of the proposed consolidation are questionable and should not be used to develop any type of budget framework should the legislature consider consolidation of the agency IT infrastructure. Also, the study completed by UmmelGroup in no way provides any framework to understand the impacts of the proposed consolidation to the agency business process.

Rather than address individual points and assumptions that are presented in the UmmelGroup study, the remainder of this report will focus on key areas where the UmmelGroup recommendations are either unfounded or incorrect. These three areas include:

1) Migration to Virtual Services provided by ITD
2) Storage
3) Impacts to Business Processes

Once these areas have been addressed an attempt will be made to develop a reasonable cost model that will more accurately represent the costs associated with migrating the Water Commission's IT hardware to the consolidated infrastructure that ITD provides.

Migration to ITD Virtual Services

One of the major assertions presented by the UmmelGroup is that the Water Commission servers be migrated to the virtual server infrastructure provided by ITD. This recommendation is confusing and is simply not based upon reality. The server infrastructure currently in place at the SWC is based entirely on Apple's Mac OSX

Server and related Apple Hardware. One of the limitations of the License Agreement provided by Apple is that Mac OSX can not be virtualized on any hardware other than Apple's. Therefore, if ITD were to provide this service using existing infrastructure they would be in direct violation of Apple's licensing agreements. If ITD is to provide this service, ITD would be required to build a new virtual service tier based upon Apple's current hardware solutions for the sole purpose of virtualizing Apple's OS. Virtual solutions are available for Apple's hardware, but are generally designed and targeted toward virtualization of a desktop host OS to provide end-user functionality. Apple's hardware simply has not been optimized to provide this class of service as an enterprise solution for hosting server solutions and likely never will.

To further confuse this recommendation, UmmelGroup makes the following assertion:

> *"Apple announced that the Xserve server hardware products would no longer be manufactured as of January 31, 2011 requiring a conversion to a different platform (likely Linux) in the near future. This is a significant effort that produces no tangible return – other than the ability to keep processing. Failure to do the conversion results in the inability to do other future updates because prerequisites cannot be met. "*

This assertion appears to indicate that Apple does not provide a viable server solution moving forward so the Water Commission should migrate our servers and related services to Linux in the near future. While this would seem to fit with the recommendation for migration to ITD's virtual services, it ignores some very basic facts. First, when we met with UmmelGroup, we explained that the xServe infrastructure was at end-of-life, and was going to be replaced with Apple's new MacPro. While not considered an enterprise grade server with rack mounting capabilities and lights-out-management (LOM), the MacPro still provides a viable server solution with sufficient resources to address the application requirements for the Water Commission. The agency would only lose the ability to remotely monitor the servers through the LOM and the convenience of easy rack mounting, but our application base would remain intact and unaffected.

Apparently, this explanation was not sufficiently "Enterprise" for the UmmelGroup and it was dismissed out of hand. In December, the Water Commission did in fact purchase and deploy MacPro hardware to replace the xServe platform as had been outlined in our 2013-15 strategic plan. As expected our application base migrated with minimal modifications and no disruption in service. In fact, the migration only required approximately 10 staff hours to complete.

What is particularly confusing about the recommendation by the UmmelGroup is that they make the assertion to migrate, but do not address any of the costs or issues related to this migration. Nor do they define what they mean by this migration. In its current form, the application base at the Water Commission can't be migrated to Linux in it's entirety unless we completely abandon 4D and start over. A major component of the application base is provided using 4D, which will only run on Windows and Macintosh hardware. One of the major advantages that the Macintosh platform provides 4D is the ability to utilize the rich toolset that is provided by the Unix kernel on which Mac OSX runs. This is not available to 4D when running under Windows. Therefore, if the Water Commission is to migrate this application to ITD's virtual service tier, it would require the use of Windows for the 4D application base. It would also require a significant re-write to large parts of the 4D code base to re-

implement the components that utilize the Unix toolset with commercial plug-ins that might be available for the Windows platform. In addition, the migration of the non-4D application base to the Linux platform would also require significant work to adjust this code base to accommodate the Linux kernal rather than the BSD kernal that is currently underlying system under Mac OSX.

In addition to being a bit confusing, this omission also has major implications upon the costs associated with any proposed consolidation. While the UmmelGroup maintains that there are only minor costs associated with this consolidation, they are apparently advocating either partially or entirely rebuilding a code base that has been evolving for more than 25 years. This is not a minor undertaking, nor can it be ignored if we are to develop any form of a cost model that accurately reflects the impacts of these recommendations.

Another glaring problem with the UmmelGroup recommendations relates to the savings that they have identified related to pushing the Water Commission to the consolidated virtual services. The UmmelGroup asserts that consolidation would deliver up to 15% savings in staff resources to the Water Commission as a result of the consolidated services provided by ITD. They then extrapolate those savings out to include all four of the positions that are housed in the IT section. In reality, only two of the positions in the IT section are involved with server administration. It would be more reasonable to place the overhead of the current administration of the server infrastructure at approximately 10% of these two positions. However, UmmelGroup has indicated that ITD should create the virtual service and then turn it over to the agency with full administrative privileges. With this model the bulk of the service administration would still fall to the agency staff. It is unclear how UmmelGroup arrived at their estimate. I would not expect any staff savings as a result of this model as the agency would still be required to perform all of the same activities related to service management that we do now. The only exception to this would be in the area of equipment failure, such as RAM or drive failures. Based upon our experience managing the existing server base, I would place this saving at less than 1%.

Storage and Storage Infrastructure

The majority of the cost model that the UmmelGroup presented was tied to storage because they completely ignored the costs associated with migrating the large application base. They quickly reviewed what the Water Commission had identified as storage that was directly attached to the server infrastructure located at the State Office Building location, and then applied rates for an unpublished storage tier that was not yet provided by ITD and presented a number. Again, they did not take the time to really review our infrastructure, nor did they take any time to develop an understanding of how the Water Commission utilizes storage. They didn't even take the time to understand or identify which components of the server attached storage would qualify for this new "unpublished" storage tier, they simply applied all of the storage to this new tier.

Since the completion of the UmmelGroup study, ITD has now published the storage rates for the upcoming biennium, which includes the tier that the UmmelGroup was directed to use in their analysis. While the UmmelGroup was directed to use $50/TB, ITD's published rate for this tier is $75/TB, which is 50% higher than the rate UmmelGroup was directed to use. While this new storage tier does represent significant saving over previous rates from ITD, not all of the server-attached storage at the Water Commission would qualify for this new storage tier. In

addition, the server-attached storage does not present an accurate picture of total storage requirements for the Water Commission.

At the time of the study, approximately 100 TB of server-attached storage was identified in the primary data center and approximately 140 TB was identified in the remote data center. The UmmelGroup concluded that the new "unpublished" storage tier could be utilized for 100 TB of storage to address the needs for the Water Commission. The storage at the remote data center could be replaced by the available backup services that ITD provides in Mandan, but they neglected to include these costs in the estimates presented for the storage. After visiting with ITD about the types of storage that would qualify for this new storage tier, it is reasonable to assume that approximately 70 TB of the initial 100 TB would qualify for this new tier. However, the prices that were attached for the purpose of the consolidation study did not include any backup for this particular tier. Therefore, the numbers presented by the UmmelGroup do not even represent the total costs associated with this tier.

This leaves the remaining 30 TB to be implemented under existing ITD service tiers that are significantly more expensive. In addition, there is an additional 30 TB of storage that currently sits on individual desktop machines throughout the agency that are not included in the balance of storage that is server-attached. The Water Commission is unique in that we do not require users to work from a server share. Every workstation is backed up to our remote data center on an hourly basis. Under the consolidated model that ITD provides, all of this storage will be required to be placed on the server infrastructure otherwise it will not get backed up. So as a result, we are looking at 60 TB of storage that will require implementation within ITD's standard File and Print service tier or other storage tiers.

Impacts to the Business Process

Even though the UmmelGroup was directed to evaluate the impacts that the consolidation would have upon stakeholders, no information was presented to identify any impacts either positive or negative on any stakeholders other than the IT staff. While the impacts of the proposed consolidation to the business process may be more difficult to assess, it is entirely likely that the resulting impacts to the business process would far exceed the IT costs associated with consolidation.

In order to understand this point, all that is needed is to evaluate the difference between the costs associated with some of the simpler services that the Water Commission has developed versus costs that would be incurred at ITD. Recently, the Water Commission developed a solution to manage and disseminate LiDAR data. This service was developed to make it easier to manage the very large data stores that result from large aerial LiDAR data collection projects.

LiDAR is used to develop digital elevation models and requires massive amounts of data to cover the large basin areas that are generally targeted. At the same time that LiDAR is becoming cheaper to obtain, technology is making it easier and easier to utilize for all types of analysis. As a result, LiDAR resources that are available within North Dakota are growing by several terabytes per year. In order to make this data useful and accessible not only by agency staff, but others in the state, federal, and public domains, the data needs to be organized and on-line. Without this type of organization, there will be situations where there are redundant data collection efforts, LiDAR data that is not fully utilized, and an array of other issues related to the inefficient management and use of these data.

The Water Commission has developed a LiDAR Dissemination service that effectively addresses all of these issues and more. Not only does this site provide an effective management tool that allows anyone interested in LiDAR data to review available assets, it also provides self-service capabilities for anyone that needs these resources to select and download the data that is required for their respective project.

Currently, when faced with the development of a management solution such as this, the Water Commission will evaluate relevant costs and priorities within the agency budget. When developing an IT management solution, the Water Commission must evaluate the overall needs of the business process and determine if the return on investment (ROI) is sufficient to warrant the development of the related infrastructure. The result of this type of analysis is that the technology solution is effectively matched to the business need and agency budgetary constraints. This type of analysis does not happen when working with centralized IT environments like ITD. When ITD develops this type of project, they are not required nor do they have any perspective of the business need. As a result, they tend to build IT projects not business projects.

This point becomes more clear when you evaluate the storage needs for the LiDAR Dissemination service. LiDAR generates very large data sets. Currently, the Water Commission maintains approximately 20 TB of storage capacity to house the current LiDAR resources in North Dakota. This number is expected to exceed 100 TB within 5 years. LiDAR data is very large, but it is static. So once collected the data never changes. The storage requirements for this type of data are very different than the storage requirements for a database application or even for more general-purpose file sharing in a workgroup environment. As a result, the Water Commission can target storage that appropriately meets the operational requirements for the data. On the other hand, ITD generally targets operational requirements for the management of the storage and related infrastructure. This may seem like a subtle difference in management focus, but it produces profound differences in the costs associated with the deployment of the storage solution.

For these types of IT challenges, ITD has historically moved very slow. The Water Commission and by extension the GISTC has been pushing ITD for nearly 10 years, with an initial memo addressed to Lisa Feldner (CIO) as early as February of 2007 to provide a more cost effective storage tier to address these types of data storage requirements. For the coming 2015-17 biennium, ITD has finally addressed this tier of storage with a new High Volume/Low Use tier with an acquisition cost of $2,000/TB and monthly costs of $75/TB. This brings the total amortized cost for this storage tier (over 4 years) to almost $117/TB. By comparison, the storage currently utilized by the Water Commission for the same purpose has an acquisition cost of $230/TB with no ongoing monthly costs, which brings the total amortized cost for the SWC storage to approximately $4.79/TB. When you factor in the administrative overhead related to the acquisition, management, and maintenance, the amortized costs don't exceed $6.00/TB. These types of cost differences are not unique to storage and as a result, the cost of utilizing technology solutions provided by ITD tends to be over 20 times higher than solutions that are developed internally.

If you apply these metrics to the LiDAR service that was described earlier, storage costs will approach approximately $14,000 over a biennium as the LiDAR service storage footprint approaches 100 TB. By contrast, storage costs for this same service will exceed $280,000 using the storage services provided by ITD.

In the case of many of the data resources that are currently managed and disseminated by the Water Commission, the solutions that ITD provides are simply too costly. As a result, many of the management systems such as the LiDAR Dissemination service, Aerial Image Service, Survey Information system, and many other solutions simply would not have been created if the Water Commission were mandated to utilize ITD. It is also entirely likely, that many of these will be shut down if the agency is mandated to utilize ITD services because it would be difficult to justify the on-going maintenance costs associated with these services under the rate structures that ITD currently supports.

Projected Costs for Consolidation

For the purpose of this memo, the costs that will be presented here will assume that the agency will be allowed to maintain the 4D infrastructure and that the agency staff will be able to successfully migrate this infrastructure to Windows. In addition, it will be assumed that the open source solutions that have been employed for the GIS infrastructure, which includes, PostgreSQL, PostGIS, MapServer, and QGIS will be maintained as well. This is not a trivial assumption as none of these are currently supported by ITD. However, in the interest of developing a baseline to begin evaluating the costs associated with consolidation, the cost estimates developed here will be based upon these assumptions. This is the only approach that will allow us to compare the costs estimates presented by UmmelGroup. If these assumptions are not made and the agency is forced to abandon these solutions in favor of the more central supported solutions provided by ITD, the costs associated with consolidation will be considerably higher than the costs presented here.

The costs developed here are based upon the 2015-2017 Data Processing Rates that were recently published by ITD. The costs presented here will include the following categories:

- Server Infrastructure
- Storage
- Records Management
- Application Services
-

Currently, the Water Commission maintains the following server infrastructure at the State Office Building (SOB).

Server	Storage	Purpose
Open Directory Server	250 GB	Provides directory services for internal agency resources. Also provides MDM solution and Profile Management for Desktop machines. Services: OpenLDAP
Open Directory Replica	250 GB	Provides backup directory services and supports ESRI license manager

		Services: OpenLDAP / LVM
Agency File Server	10 TB	Provides general File Services for agency staff Services: AFP, SMB
Imagery Server	40 TB	Provides management and distribution for the wide array of aerial image assets currently maintained by the SWC Services: PostgreSQL, PostGIS, MapServer, Apache
LiDAR Dissemination Server	30 TB	Provides management and dissemination services for the LiDAR data assets available in North Dakota. Services: PostgreSQL, PostGIS, MapServer, Apache
IRIS Analysis Radar Operations Server	1 TB	Provides Radar operational control and radar imaging for the Meteorological services for the Atmospheric Resources cloud seeding and flight operations. Services:
Web Server/Spatial Server	70 TB	Provides agency web services, GIS spatial services. Services: PostgreSQL, PostGIS, Apache, MapServer
4D Server 1	5 TB	Provides application services for agency business applications including Well Inventory, Water Permits, Survey and Benchmark data, MR&I System. All of these include document management and records management components. Services: 4D Application Server, File Sharing (AFP, SMB)
4D Server 2	5 TB	Provides application services for agency business applications including Records Management, Retention Structures, Precipitation Observers, General Purpose Agency Admin, Flight Contorl and Operations. All of these include document management components. Services: 4D Application Server, File

		Sharing (AFP, SMB).
Staging Server	10 TB	Provides an independent service tier utilized for the maintenance and on-going support for the application base that is hosted on 4D Server1 and 4D Server 2. All changes are deployed and tested on this platform and then pushed to the respective production platform for production deployement Services: PostgreSQL, PostGIS, Apache, MapServer, 4D Application Server, File Sharing (AFP, SMB)
Development Server	10 TB	Provides a testing platform to support new development and major open-source and commercial software changes. This server is used to test and identify new services as well as major upgrade changes to existing software and services that will eventually need to be pushed to the staging and production servers. Services: PostgreSQL, PostGIS, Apache, MapServer, 4D Application Server, File Sharing (AFP, SMB)
Total Storage	161.5 TB	

While the following server infrastructure is maintained at our remote shop facility at 2901 East Main Ave.

Server	Storage	Purpose
Aerial Backup	42 TB	Provides back up services for the SWC Aerial Image Service
NHD Backup	30 TB	Provides Backup solutions for the LiDAR server.
Time Machine 1	30 TB	Provides general desktop backup for agency users
Time Machine 2	30 TB	Provides general desktop backup for agency users
Time Machine 3	30 TB	Provides general desktop backup for agency users
Time Machine 4	40 TB	Provides general desktop backup for agency users
Total Storage	202 TB	

All of the servers located in the remote data center are dedicated to backup services and would be eliminated under the consolidated model. While there would no longer be server costs, there will be backup services that will need to be addressed and included into the total storage costs that will be presented later.

All of the servers with the exception of the two directory servers will be required to migrate to the new consolidated infrastructure provided by ITD. The directory servers will be eliminated in favor of the directory services provided by ITD through Active Directory. This leaves the remaining servers for which costs will need to be developed.

File and Print

The Water Commission currently maintains a file server for the purpose of providing shared group storage for agency users. However, unlike most other agencies in state government, the Water Commission provides a robust backup solution for all of the agency desktop machines. As a result, the storage footprint maintained at the server level is approximately 10 TB. When conducting an inventory of available desktop storage, there is approximately 30 TB of disk space currently being utilized at the agency desktop level excluding general OS and other base storage associated with each machine. Therefore, the Water Commission will require approximately 40 TB of storage for the File and Print services that will be provided under consolidation to ensure that everything is backed up properly.

Given the volume of storage and the nature of the types of files that are currently being stored by the Water Commission, it would be appropriate to pursue the dedicated File and Print High Capacity Server tier provided by ITD.

Acquisition Costs	
Dedicated Server Install (standard virtual server)	$1,050
Disk Storage – File Share Dedicated (40 TB)	$104,000
Total Acquisition Costs	$105,050
Biennial Maintenance Costs	
Dedicated F&P High Capacity Server ($775/mo)	$18,600
Disk Storage – File Share Dedicated (40 TB @ $225/TB)	$216,000
TSM Disk Backup (40 TB X 2 @ $150/TB)	$288,000
Total Maintenance Costs	$522,600

Records Management

The Records Management system that the Water Commission has developed is based upon the integration between the 4D application tier and Apple's underlying Mac OSX Server. Apple's base server OS provides most of the sophisticated user interface elements of this management system, which includes server side spotlight search indexes, CoverFlow, and QuickLook. The Water Commission has effectively integrated this system with all of the existing application services provided by 4D to provide users with a simple and elegant utility for storing all of the major types of documents and document workflows that reside within the agency. This includes the utility to integrate both long-term records archival with short-term document management and workflow management. This system houses all major graphics formats, PDF's, text, rich text, and e-mail documents.

If the Water Commission is to be consolidated, this system will be lost as it is dependent upon Apple's underlying Mac OSX for much of the functionality. In order to consolidate the 4D application service tier, it must be moved to Windows. As a result of this migration and in order to benefit from the intent of consolidation, the Water Commission will need to migrate this functionality to ITD's current records management service solution. However, given the integrated nature of the records archival and the workflow management that exists with the current system, the Water Commission will need to implement both FileNet and SharePoint. SharePoint will provide the necessary tools for the workflow management; while FileNet provides the long-term records archival. It is not clear as yet how these products can be integrated, but they do provide sufficient feature sets to accommodate this integration and provide an effective replacement to the current system that is in place at the Water Commission.

Costs will be developed for both FileNet and for Sharepoint to provide baseline consolidation costs. However, there will also be additional one-time costs associated with the migration and implementation that will not be developed here. The Water Commission has obtained preliminary estimates from AOS for the design of the SharePoint application framework at $9,000 with an additional $15,000 estimated to cover the integration that will be required between SharePoint and FileNet. In addition to the FileNet and Sharepoint fees, the Water Commission would also be assessed for the related storage fees. Currently, the Water Commission maintains just under 10 TB in the current Records Management Structure.

Acquisition Costs

Application Design	$24,000
SharePoint Install (90 FTE @ $160)	$14,400
EDMS User Install (90 FTE @ $275)	$24,750
EDMS ILINX Data Capture (15 FTE @ $2,900)	$43,500
EDMS ILINX Email Import (90 FTE @ $71/mailbox)	$6,390
Total Acquisition Costs	$113,040

Biennial Maintenance Costs

EDMS User Fee (90 FTE @ $30.75/ Month)	$66,420
EDMS ILINX Data Capture Fee (15 FTE @ $91.50/Month)	$32,940
EDMS ILINX Email Import (90 FTE @ $3.60/Month)	$7,776
SharePoint MOSS Fee (90 FTE @ $15.80/Month)	$34,128
Disk Storage – Premium (on demand – approx. 10 TB @ $500/TB)	$120,000
TSM Disk Backup (approx. 10 TB @ $150/TB)	$36,000
Total Maintenance Costs	$297,264

Application Services

The UmmelGroup indicated in their report that ITD would need to change the virtual services that they provide in that they would need to turn up the service and then provide administrative flexibility to the agencies. This is at the heart of the assumptions that were presented for this cost analysis, and if these assumptions are used, then the development of costs for the application services becomes a simple matter of identifying the costs for the virtual services and related storage costs. Therefore, the costs developed for the application services will be based upon these assumptions. To this end, the current server infrastructure provides a fairly effective road map.

LiDAR / Aerial Image Services - The Water Commission maintains the Imagery Server and the LiDAR Dissemination for purposes of managing and distributing large aerial image and LiDAR data assets. These services have been developed to support internal agency staff as well as the broader engineering and scientific community inside and outside of state government. As such, these services are for the most part stand-alone services and are not integrated with other services within the Water Commission technology infrastructure.

Acquisition Costs

Dedicated Server Install - standard virtual server (2 @ $1,050/Server)	$2,100
Disk Storage – High Volume/Low Use (70 TB @ $2,000/TB)	$140,000
Total Acquisition Costs	$142,100

Biennial Maintenance Costs

Dedicated Intel Virtual Server Hosting (2 @ $360/ Month)	$17,280
Disk Storage – High Volumne/Low Use (70 TB @ $75/TB)	$126,000
TSM Disk Backup (approx. 70 TB @ $150/TB)	$252,000
Total Maintenance Costs	$395,280

IRIS Analysis Radar Operations Server - The Water Commission maintains the IRIS Analysis Radar Operations Server to provide operational management and control for the Radar Operations centers in Stanley and Bowman. In the past, these services were maintained just during the summer months to provide radar services in support of the Flight operations surrounding cloud seeding program for western North Dakota. However, the Bowman Radar Operation center has now been converted to year round service to fill in gaps in the radar coverage in western North Dakota. This operation now supports both the weather service and emergency operation for this region.

This server provides a fairly unique service and requires custom PCI cards. I do not think that it can easily be supported in a virtual environment. Therefore, we will use the Dedicated Intel Physical Server solution identified in ITD's rates to develop appropriate pricing. This server does not have significant storage requirements; therefore, no additional costs were included to support storage beyond that which will come installed in the native hardware.

Acquisition Costs

Dedicated Server Install – dedicated hardware (~ $2,000/Server)	$2,000
Total Acquisition Costs	$2,000

Biennial Maintenance Costs

Dedicated Intel Physical Server Hosting (1 @ $750/server)	$18,000
Total Maintenance Costs	$18,000

WebServer / Spatial Server – This server provides a combination of services that are inherently integrated. The Water Commission maintains a number of web services in addition to the standard agency web service. Most of these include map services, spatial services or other data-driven services. The architecture of this server is designed completely around open-source solutions including PostgreSQL, PostGIS, MapServer, Apache, and more. The services developed on this server include significant data resources that are accessed either through specialized services or are consumed directly by many of the 4D application services. As a result this server requires significant data stores to house the relevant vector and raster data. The Water Commission currently maintains approximately 70 TB of disk on this service. Given the nature of the data, some of this storage would qualify for the High Volume/Low Use, but some would also require more a more robust storage capability. For purposes of developing costs, a total of 50 TB will be applied at the High Volume/Low Use, while the remaining 20 TB will target the Basic Dedicated solution

Acquisition Costs

Dedicated Server Install (standard virtual server)	$1,050
Disk Storage – High Volume/Low Use (50 TB @$2,000/TB)	$100,000
Disk Storage – Basic Dedicated (20 TB @ $3,150/TB)	$63,000
Total Acquisition Costs	$164,050

Biennial Maintenance Costs

Dedicated Intel Virtual Server Hosting (1 @ $360/ Month)	$8,640
Disk Storage – High Volume/Low Use (50 TB @ $75/TB)	$90,000
Disk Storage – Basic Dedicated (20 TB @ $275/TB)	$132,000
Total Maintenance Costs	$230,640

4D Application Services – The agency currently maintains two separate servers to house the agency primary line of business application services. These application services are all provided using a client-server solution based 4D. 4D provides a cross-platform solution that will run both the server and client side on either the Macintosh or Windows platform. Currently, the Water Commission has licensed the 4D application server for the Macintosh platform and has integrated a number of services including the records management solution. However, if the agency migrates the records management solution to FileNet and SharePoint as previously described, it will be much easier to move 4D from the Mac platform to the Windows platform that will accommodate the virtual services that ITD provides.

In order to move 4D to the Windows platform, the records management must first be migrated. In addition, there are additional tools that will require time and effort to port to the Windows platform so that they will continue to be available as API extensions to 4D. The integration of the records management and the proposed FileNet/SharePoint solution will also require significant effort to re-design within the 4D application framework.

While it is difficult to define actual costs, it is not unreasonable to assume that the integration of these services will require approximately 500 hours to establish the code base and then 100 per 4D instance to implement. There are currently 4 different 4D applications that utilize the records management so this would provide a total of 900 hours to implement. Using the Project Manager rate of $95.00/hour, this places a total programming cost at $85,500.

In addition to the programming costs associated with the records management, there will also be some costs associated with moving the Fortran libraries and related toolset that is currently used to extend 4D for many of the spatial tools such as VertCon. Most of these are fairly small code bases and should compile generically on almost any platform. Conservatively, it would not be unreasonable to estimate an investment of approximately 100 hours to implement these library extensions to 4D on the Windows platform, which would add an additional $9,500 to the conversion costs.

Beyond the two production servers dedicated to the 4D application services, the agency also maintains a staging server and a development server. The purpose of the staging server is to address bug fixes and to provide full testing for code changes and relevant infrastructure changes that may occur during routine maintenance releases of 4D and related software. All programming, testing, debugging, and implementation issues are first developed on the staging server prior to final release and implementation on the related production environment. The Development server is used for broader testing where the agency can test the impacts of major OS upgrades, major software releases, or the implementation of entirely new libraries or services that are not currently part of the staging or production environments. Both server are critical for the long-term management and development of this application base and will be required under the proposed consolidation model.

Storage requirements for the Application Service tier will be reduced with the removal of the records management. However, there will still be the need for approximately 22 TB of storage. Given the fact that the majority of this storage will be implemented under the development and staging platform, the High Volume/Low use tier will likely be adequate for approximately 20 TB of the defined storage. The remaining 2 TB will require the Basic Dedicated storage tier.

Acquisition Costs

Records Management API Conversion	$85,500
Spatial Library Conversion (Fortran)	$9,500
Dedicated Server Install – standard virtual server (4 @ $1,050)	$4,200
4D Windows Licensing (4 Server/44 user concurrency)	$25,040
Disk Storage – High Volume/Low Use (20 TB @ $2,000/TB)	$40,000
Disk Storage – Basic Dedicated (2 TB @ $3,150/TB)	$6,300
Total Acquisition Costs	$170,540

Biennial Maintenance Costs

Dedicated Intel Virtual Server Hosting (4 @ $360/ Month)	$34,560
4D Maintenance (4 Server/44 user concurrency)	$22,000
Disk Storage – High Volume/Low Use (20 TB @ $75/TB)	$36,000
Disk Storage – Basic Dedicated (2 TB @ $275/TB)	$13,200
TSM Disk Backup (approx. 20 TB @ $150/TB)	$72,000
Total Acquisition Costs	$177,760

MDM Services – The MDM services currently reside on the agency Open Directory server. When this server is removed, the MDM service will need to be migrated to the MDM services currently provided by ITD.

Acquisition Costs

Zenprise Mobile Management (45 Users @ $75/user)	$3,375
Total Acquisition Costs	$3,375

Biennial Maintenance Costs

Zenprise Mobile Management (45 Users @ $8.75/user)	$9,450
Total Acquisition Costs	$9,450

Summary

The following summarizes the total acquisition costs and the biennial maintenance costs associated with the proposed consolidation.

Total Acquisition Costs

File and Print	$105,050
Records Management	$113,040
Application Services (LiDAR/Aerial)	$142,100
Application Services (IRIS)	$2,000
Application Services (Web/Spatial)	$164,050
Application Services (4D)	$170,540
MDM Services	$3,375
Total Acquisition Costs	**$700,155**

Total Maintenance Costs

File and Print	$522,600
Records Management	$297,264
Application Services (LiDAR/Aerial)	$395,200
Application Services (IRIS)	$18,000
Application Services (Web/Spatial)	$230,640
Application Services (4D)	$177,760
MDM Services	$9,450
Total Maintenance Costs	**$1,650,914**

Conclusions

The consolidation study that was submitted by the UmmelGroup contains so many glaring problems with the assumptions that were inappropriately applied. It is also clear that their analysis is flawed and problematic. The basic numbers that they presented were likewise flawed and problematic. When comparing the limited analysis presented here to the UmmelGroup methodology, it is clear that the projected costs that they have outlined are well below the costs that will likely be encountered moving forward if the Water Commission is to be consolidated. The costs that were developed and presented here are based upon some of the assumptions that UmmelGroup presented for the virtual environment that ITD was advised to provide. This includes providing the administrative utility to the agency staff so they can effect any changes on the virtual platform to the same degree that they can with current server hardware. ITD does not currently provide this flexibility, and it remains to be seen if they will moving forward. If we do not use these assumptions then actual consolidation costs will far exceed those costs developed here because this will force the agency to re-build many of the large integrated applications that utilize the open-source and 4D.

While it is possible that there may be some merits to argue in favor of consolidation, the UmmelGroup clearly did not provide any compelling arguments to support their recommendations. Regardless, it would not be wise to proceed forward using the numbers provided by UmmelGroup as a benchmark for the costs of consolidation.