

Development Of Software Tools Using ArcGIS For Land-Use Control Management

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Abstract

Traditional tracking of Air Force infrastructure projects requires the incorporation of environmental review, to insure that new construction/excavation work does not occur in areas known to have environmental contamination. Historically, this process allowed for a large degree of variation of review comments to a proposed project. To minimize/eliminate this variation an ArcGIS based decision-making tool was created. This application implements a decision-making logic that allows the user to automate responses based upon the most up to date geospatially referenced data.

1.0 Introduction

Recently the 45th Space Wing (45 SW) Installation Restoration Program (IRP) Office designed a GIS tool that allows for more thorough environmental review of proposed projects. Due to the large volume of both construction and excavation projects that are required to maintain a state of readiness on an active military installation it was decided that reviews of these projects should be automated to provide a project proponent with a concise, current, and consistent review of a site plan with regard to possible environmental contamination on the site.

1.1 General Background

The 45th Space Wing is responsible for the operation of the Eastern Test Range. The predominant mainland facilities are Cape Canaveral Air Force Station and Patrick Air Force Base. There are also several downrange facilities, namely Antigua and Ascension Island Tracking, which fall under the command of the 45SW.

1.1.1 45th Space Wing Installation Restoration Program

There are approximately 250 Solid Waste Management Units (SWMUs) at Patrick Air Force Base (PAFB) and Cape Canaveral Air Force Station (CCAFS). It is the responsibility of the IRP Office to ensure that proposed construction projects on any SWMU are informed of the restrictions and limitations posed by site contamination. The

contamination on these sites is largely the result of space launch operations and the support of these operations (i.e. solvent cleaning of critical systems, purging of fuel systems to the environment, disposal of waste products associated with preparation of launch systems, and normal wastes generated from the maintenance of facilities on the installation). The 45th SW has developed a “dig permit process” that ensures all impacted organizations have an opportunity to review and provide comments on proposed construction projects. The IRP is one of the offices that reviews all dig permits. Due to the number of SWMUs and the volume of dig permits, the IRP required a system that tracks all of the dig permits reviewed, as well as the ability to generate a standardized dig permit response form.

1.1.2 Cape Canaveral Air Force Station (CCAFS)

INSTALLATION DESCRIPTION AND ENVIRONMENTAL SETTING

CCAFS is located in Brevard County on the east coast of Florida, approximately 15 miles north of Patrick AFB. CCAFS occupies approximately 15,800 acres of coastal strip on a barrier island that is bound by the Atlantic Ocean to the east and the Banana River to the west. CCAFS is bound to the north by the KSC (a NASA facility)/Merritt Island National Wildlife Refuge, and on the south by Port Canaveral. The city of Cape Canaveral is located adjacent to the south side of Port Canaveral, followed by Cocoa Beach and Patrick AFB further to the south. The city of Cocoa is located to the southwest, across the Banana River. Little relief characterizes the topography of the installation, and much of the installation is covered with native vegetation. The natural environment of the barrier island includes habitats for numerous rare, threatened, or endangered species.

CURRENT MISSION AND HISTORY OF INSTALLATION OPERATIONS

CCAFS is home to the 45th Space Wing. The mission of the 45th Space Wing is to conduct and support space and missile launches, operate the Eastern Range, respond to worldwide contingencies, and host the Cape Canaveral community. CCAFS was selected as the site for a United States Missile Testing Range in 1947. On 9 May 1950, work began on the first paved road and permanent launch site. A German V-2 rocket with an Army WAC Corporal second stage was launched from CCAFS on 24 July 1950. This configuration, known as BUMPER, signaled the beginning of the space age. Although the Army’s BUMPER launches at CCAFS were followed by the first REDSTONE ballistic missile launch in late August 1953, aerodynamic or “winged” missiles, such as the MATADOR, dominated the launch schedule at CCAFS for most of the 1950s. The first MATADOR launch was in 1951, followed by the BOMARC, SNARK, and NAVAHO cruise missile programs. In 1953, emphasis shifted to ballistic missiles with the first JUPITER C launches at CCAFS in 1956, followed by the THOR, the Navy POLARIS, and the Air Force ATLAS. Other programs have included: TITAN, PERSHING, DELTA, POSEIDON, MINUTEMAN, TRIDENT, and Short-Range Attack Missiles. Since 1981, the Eastern Range has taken the lead in support of NASA’s Space Shuttle Program, as well as Lead Range for the Strategic Defense Initiative

Organization's in-orbit testing, which opened the door to a new era in space technology. The primary mission of CCAFS is to provide the launch site, facilities, hardware, and support required to assemble, process, checkout, test, and launch all types of space boosters, upper stages, satellites, and other pay loads. CCAFS also provides the facilities, infrastructure and ground support for the Eastern Range's launch based instrumentation requirements, including radar, telemetry, optics, command and control, communications, and collection and real-time processing of data. CCAFS provides logistical support to the following major organizations in support of their primary mission: Naval Ordnance Test Unit (NOTU), NASA, U.S. Army, and other DoD and commercial organizations.

1.1.3 Patrick Air Force Base (PAFB)

INSTALLATION DESCRIPTION AND ENVIRONMENTAL SETTING

Patrick AFB is located on 2,108 acres on a barrier island along the central east coast of Florida, just south of the city of Cocoa Beach. The main base contains approximately 1,791 acres and is bounded on the east by the Atlantic Ocean and on the west by the Banana River. U.S. Route A1A, the major north-south highway along Florida's east coast, traverses the base. The south housing area is located approximately one mile south of the main base, consists of 317 acres, and supports military family housing and related community facilities. The base topography is characterized by little relief.

CURRENT MISSION AND HISTORY OF INSTALLATION OPERATIONS

Patrick AFB was established in 1940 by the U.S. Navy as the Banana River Naval Air Station, and served as an active base for antisubmarine sea-patrol planes during World War II. The base was deactivated in 1947 and transferred to the U.S. Air Force in 1948. The facility was renamed Patrick AFB in 1950 in honor of Major General Mason M. Patrick, the Chief of the U.S. Army Air Service from 1921 to 1927. In 1950, the Air Force began developing the Eastern Test Range. Since that time to the present, the 45th Space Wing has been responsible for launch, test, and support operations associated with the cruise missile program, ballistic missiles, the Apollo and Space Shuttle programs, and the Delta, Atlas, and Titan programs. The mission of Patrick AFB includes the responsibility of safety, planning, engineering, support services, scheduling, test operations, launch and range operation, directing or supporting operations, and test results evaluation for the 45th Space Wing. Also, the base provides similar support to other DoD and non-DoD programs.

2.0 GIS Applications Within the IRP Program

Historically GIS had been used within the IRP office as a mapping tool. As the complexity of the investigations grew so did the need for graphical representation of the data and GIS filled that role. Maps were consistently generated for briefings, funding documentation, site status reports.

Recently, the need for more powerful GIS-based decision making tools has arisen within the IRP. The 45th Space Wing determined that one area that would be a prime candidate for the use of GIS was the dig permit process. Project managers felt that due to the complexity of the restoration sites and the extent of contamination on the installations a more streamlined approach was necessary to insure permit compliance and to prevent impacts to human health and the environment.

2.1 Needs Analysis

For years project managers had been required to search through voluminous reports for information regarding the environmental condition of a given site. With GIS systems they would be able to access that data in a more timely fashion and would be able to make more informed decisions.

Two areas were identified within the dig permit process which could use improvement. These areas were; consistency of the comments provided and tracking of projects reviewed.

The first problem identified was the inconsistency in the comments being provided to project proponents. Different managers were using different verbiage for the same site concerns. This occasionally caused some confusion among project proponents that were not sure how to address the IRP manager's concerns/comments.

The other problem facing the IRP managers was the tracking of projects that were reviewed. In the past proponents would show a manager the proposed project location and the manager would generate review comments based upon that information. This occasionally caused problems when projects were re-sited without following up with the IRP managers. To solve this problem it was decided that all project plans being reviewed would be electronically scanned and indexed within the GIS. These scanned copies would then serve as record of exactly what had been reviewed for a given project should any changes occur between the design and implementation phase of a project.

2.2 Design

The architecture chosen for the dig permit wizard was a personal geodatabase. This was chosen due to its relative ease of implementation. Our existing GIS data was integrated into a geodatabase where all members of the IRP office could access it. By placing all of the pertinent data into a geodatabase we were assured that all of the necessary data for conducting a review would be available to everyone in the office. It was also determined by the IRP managers that the final wizard should not be fully automated due to some variations within the sites and the need to interject some human logic into the process.

The next phase of development was creating a decision logic (Figure 1) which would drive the responses generated by the wizard. This phase of the work proved to be the most challenging due to the number of variables to be evaluated in the process. However, this work would prove to be the most important step in the development of dig permit wizard as the decision logic proved to be an invaluable tool in explaining the process to several developers that were working on the project.

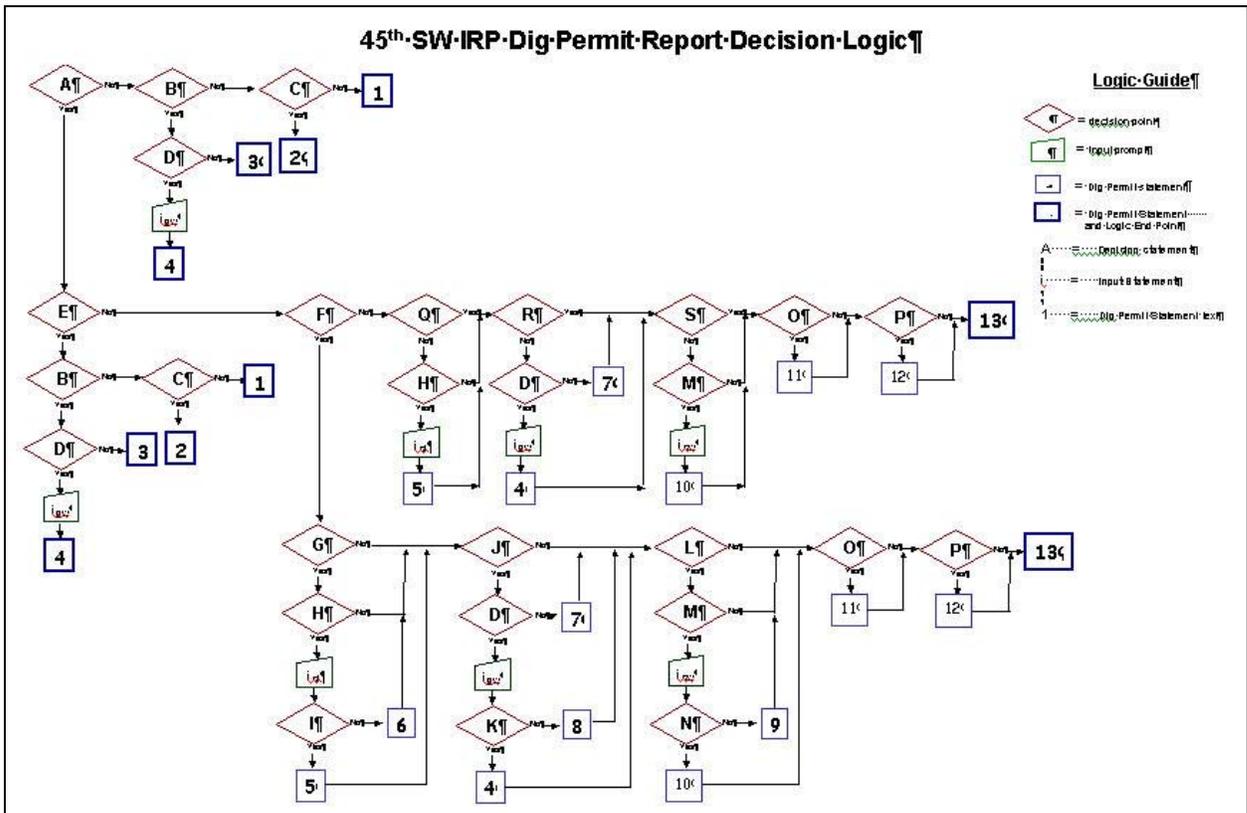


Figure 1 Simplified Dig Permit Wizard Decision Logic

Once the process flow had been evaluated and established the IRP office then had to craft the responses that would be generated by the dig permit wizard. This verbiage was adapted from language contained within the Land Use Control Agreement and the current Resource Conservation and Recovery Act Permit issued by the Florida Department of Environmental Protection.

Visual Basic (VB) code was used to program the decision logic and responses into the dig permit. This code “walks” a user through the decision logic and then generates a comments page, summarizing all of the pertinent IRP information, that can be returned to a project proponent.

2.3 Implementation

The current version of the dig permit wizard is designed to run in an ArcGIS 8.2 environment with Crystal Reports 8.5 installed. This represents the third version of the software with a fourth version currently being tested in an ArcGIS 8.3 environment with Crystal Reports 9.0 installed.

The current version is configured with a such that upon opening the user is required to choose between the two installations, CCAFS and PAFB. Following this selection the extent to zoomed to the installation of interest (Figure 2).

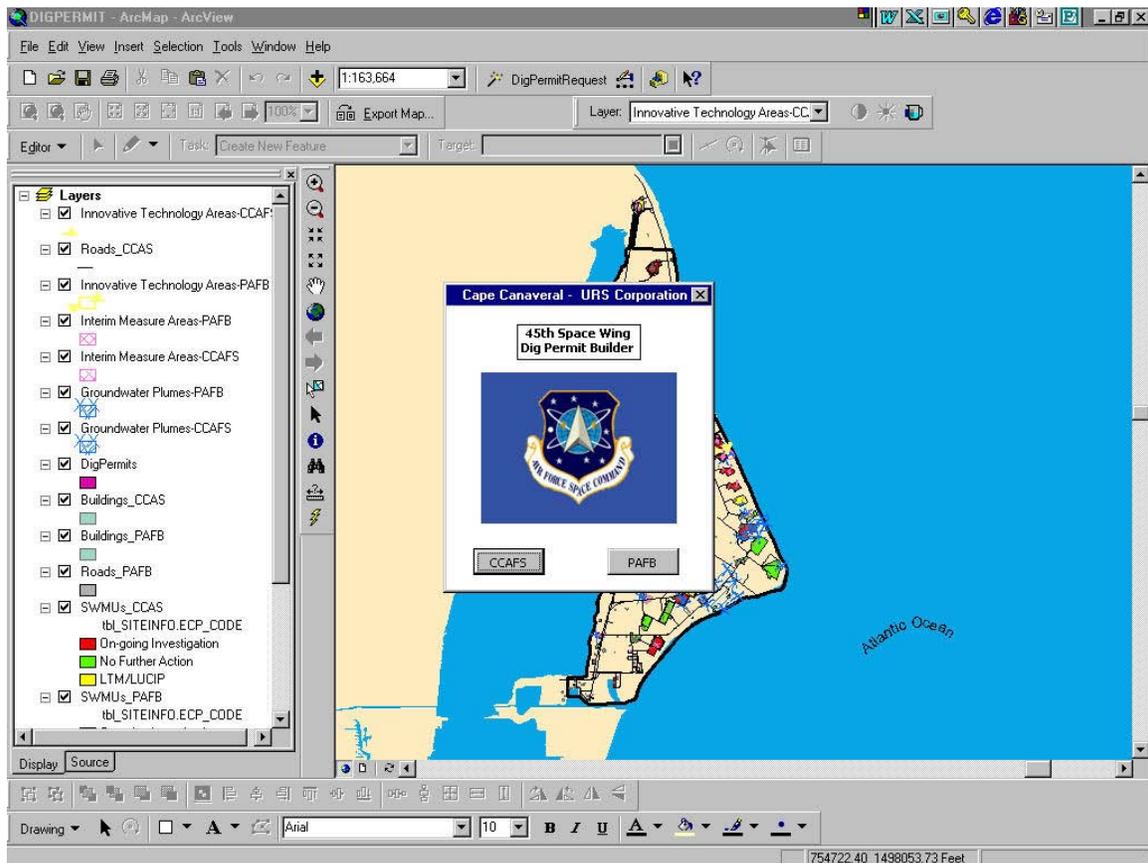


Figure 2

From this point the user is able to zoom into the area of interest on the base. Information included in the view are: groundwater plumes, SWMU Boundaries (with status); roads, buildings, monitoring wells, and innovative technology implementation areas.

At this point the user initiates the dig permit wizard (Figure 3) and begins to place points on the map representing the vertices of the project area. Following the outlining of the project area a simple right click on the mouse provides a menu of actions regarding the sketch you have just created. The user is able to delete the last point, delete the entire

sketch, add an additional area (this functionality is usually used for large infrastructure projects that have various project locations across the base); or continue on to complete the dig permit request.

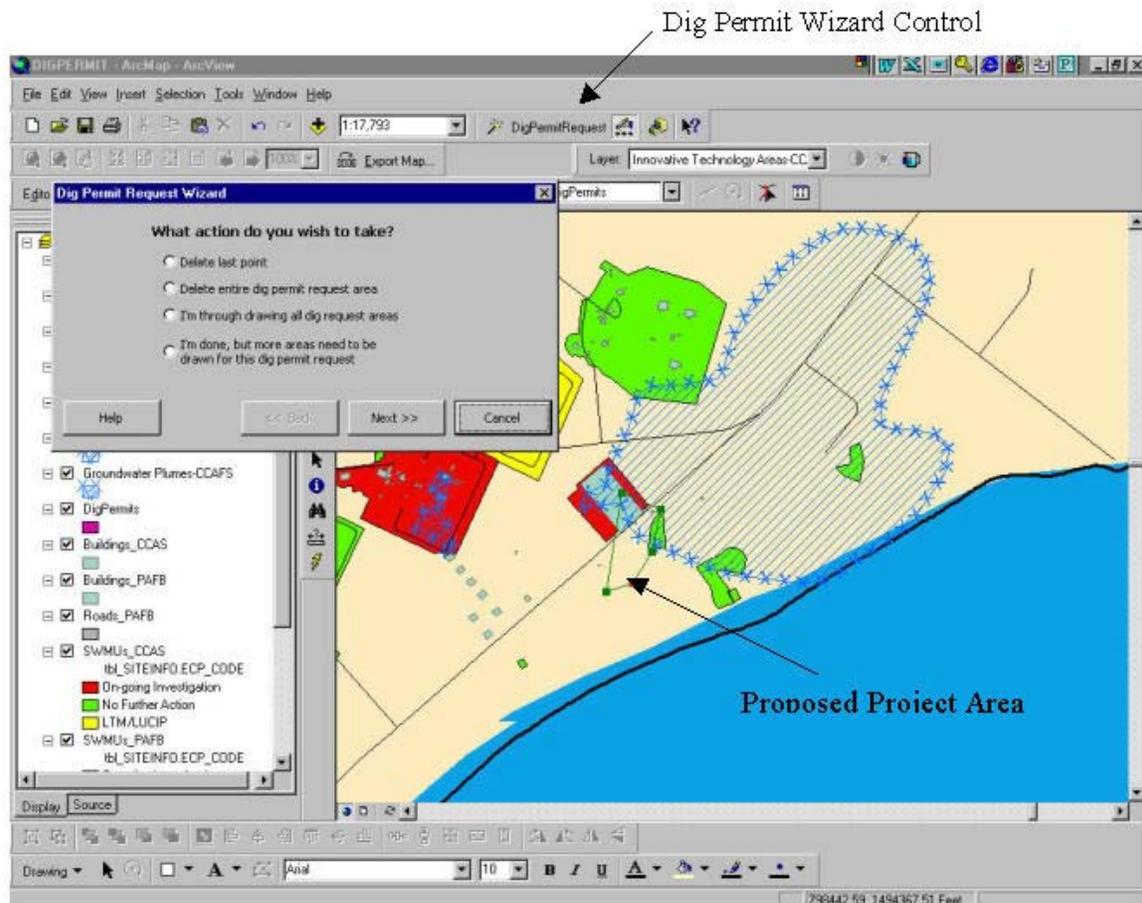


Figure 3

Figure 4 illustrates the tracking information that is required for each project. This information is used to capture as much project information as possible within the GIS.

The user is then required to browse to the location of the scanned pdf project file. The location of this file is then saved in the GIS record so that the file can be retrieved at a later time should the need arise.

From this point the user is lead through the decision logic. Figure 5 is a list of some of the questions that are asked as part of the decision logic. The contamination information is gained both from GIS data and from the manager conducting a search of any recent hard copy documents that may have recently been generated on the site.

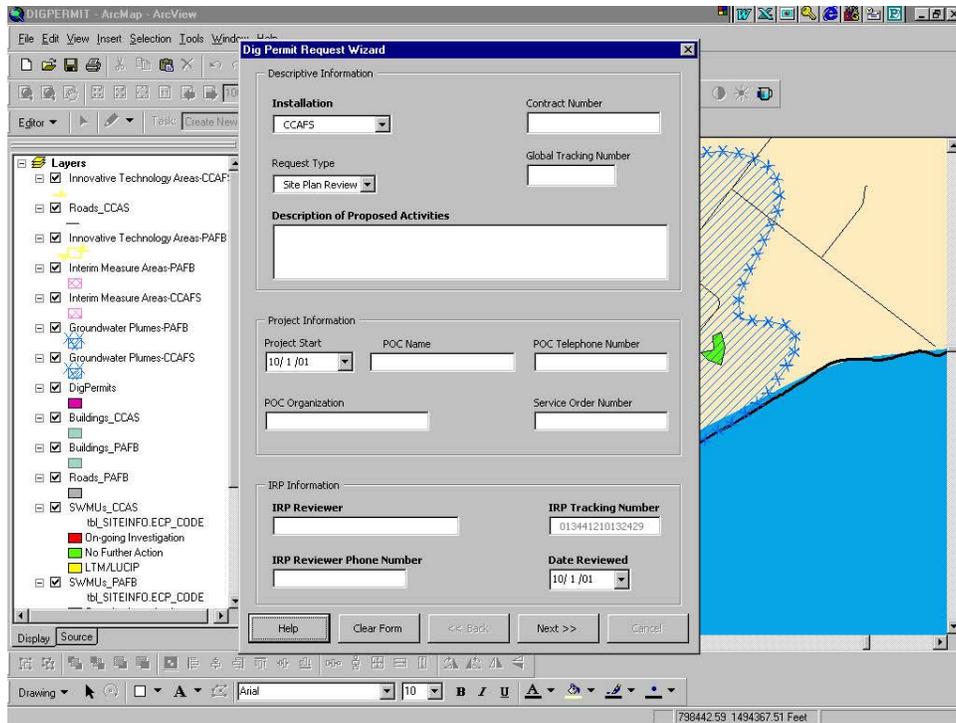


Figure 4

Is Project Site located on a SWMU?
Is Project Site located over a groundwater plume?
Is the site located on Patrick Air Force Base?
Will any dewatering, via well-points or similar technology, be performed during the life of the project; or will groundwater be otherwise contacted or impacted during the project?
Is the SWMU designated for "No Further Action" (Green)?
Is the SWMU designated for LTM and/or LUCs (Yellow)?
Is there a Soil LUC?
Will site soils be impacted, disturbed, or contacted during this project?
Do Site soils pose a potential health risk to industrial workers?
Is there a Groundwater LUC?
Does Site groundwater pose a potential health risk to industrial workers?
Is there a Surface Water/Sediment LUC?
Will site surface water or sediment be impacted, disturbed, or contacted during this project?
Do site surface water/sediments pose a potential health risk to industrial workers?
Are there any active remedial systems/innovative technology tests on or near the project location?
Is the project located on a former landfill unit?
Have IRP investigations been concluded to the extent that the IRP has been able to determine that soil poses no significant risk and will be recommended for No Further Action?
Have IRP investigations been concluded to the extent that the IRP has been able to determine that groundwater poses no significant risk and will be recommended for No Further Action?
Have IRP investigations been concluded to the extent that the IRP has been able to determine that surface water/sediment poses no significant risk and will be recommended for No Further Action?

Figure 5

Following completion of answering all of the questions in the decision logic a dig permit report form is generated through crystal reports (Figure 6). This form is returned to the project proponent along with a map illustrating the project area and any IRP areas on concern.

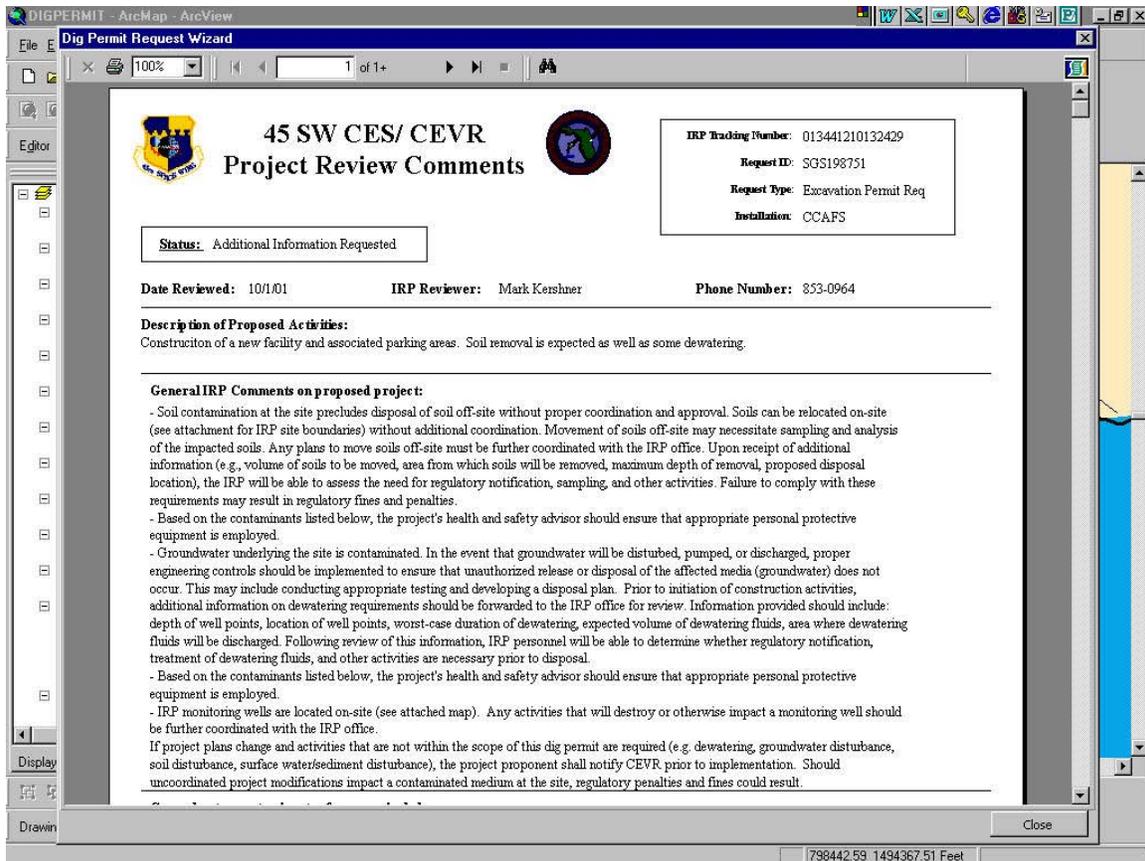


Figure 6

The wizard was also designed so that there is extended search functionality so a manager can easily find a report at a later time. Users are able to search the GIS by date range that a review was conducted, the IRP tracking number (this number is a unique date stamped identifier that is generated when a review is conducted), distance from a facility, and by SWMU.

An edit function was also incorporated so that a manager can also reopen a record to conduct edits to the data should any changes to the project occur. This edit session reopens the record within the interface that was created for the initial project review.

These last two added functionalities allow users that are not very knowledgeable in the use of GIS to have the same capabilities as user that is very familiar with the functionalities that are available within GIS.

3.0 Lessons Learned

3.1 Data Standardization and Updates

Due to the large volume of base level data being generated/updated by various entities it has become a task unto itself to ensure that the personal geodatabase is loaded with the most recent data from all parties. Additionally, in the initial creation/loading of the GDB it was necessary to convert a large number of files to one consistent datum (base data is generated in 3 formats NAD83feet, NAD83meters, and NAD27). The inability of the personal GDB to accept multiple datums has at times hindered the quick addition of other pertinent data to the dig permit wizard.

Another ongoing concurrent task has been converting all of the data used by the IRP to a SDS compliant format. As this data is converted to a compliant format it is reloaded into the wizard so that there is consistency across the program. This has caused several small problems with the wizard due to changes in the naming of files to meet the standard.

3.2 Software Updates

Throughout the design of this wizard several versions of the GIS software has been released. With each iteration of the software there have been several small issues to resolve, usually the result of changes in dll's or changes in the acceptable commands within the software. All of these problems have been relatively easy to resolve and have not degraded the usability of the GIS system.

4.0 Conclusion

The dig permit wizard has satisfied all of the requirements that drove its creation. The IRP office is now able to ensure that IRP managers have an opportunity to review and provide comments on proposed construction projects, track all of the dig permits reviewed, and the ability to generate a standardized dig permit response form. Although only currently used by the IRP office other Civil Engineering functions have shown interest in the wizard. By simply adding several new data sets and VB modules to the wizard this product could streamline the dig permit approval process across the installation.

Due to the use of visual basic code in the creation of the decision logic this wizard should prove to be easy to implement in other configurations. At this time the IRP is investigating the possibility of creating a VB application that would operate in an ArcSDE environment as opposed to a personal geodatabase. By migrating to the SDE

environment many of the shortfalls (i.e. datum conversions, data updates) of the personal geodatabase architecture could be avoided.

5.0 Author Information

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