Increasing Efficiency and Accuracy in Post-Disaster Data management

1. SITUATION

 1.1. Summary

Recurring natural and manmade disasters demand that damage assessment and other recovery-oriented data be collected rapidly and accurately, in order to enable emergency management officials to marshal the proper resources to mitigate physical damage and human suffering. Beyond the collection of data, the need to request funding and in-kind assistance from higher echelons requires that the data be recorded and communicated accurately and clearly according to prescribed formats. To this end, the South Carolina Emergency Management Division (EMD, SCEMD) engaged PinPoint GeoTech, LLC to provide, customize, install, and provide training on its PinPoint-DisasterWorks^{tm} system.

The objectives of this project are to simplify, streamline, and automate field data collection techniques to achieve:

- total situational awareness

- faster damage assessment and cost estimation

- accurate information, and

- faster resolution of post-disaster issues.

Following the implementation discussed in this case study, regional and county EMD organizations will be added to the system implementation, as well as private disaster relief organizations such as the American Red Cross and church-affiliated groups.

The system is already in use in church affiliated disaster relief organizations.

Ultimately other states and the federal government should find the system useful in their disaster recovery missions.

This Case Study documents the implementation of the PinPoint system by the SCEMD, from initial procurement through deployment and continuing evaluation in the field.

Appendix A contains a List of Abbreviations used in this case study.

1.2. Client: The South Carolina Emergency Management Division

The SCEMD is a state organization functioning under the direction of the South Carolina Adjutant General, who reports directly to the Governor. Its operations, including procurement of goods and services, are funded by State of South Carolina appropriations.

SCEMD Mission Statement

The mission of the South Carolina Emergency Management Division is to develop, coordinate, and lead the state emergency management program, enabling effective preparation for, and efficient response to, emergencies and disasters in order to save lives, reduce human suffering and reduce property loss. To accomplish this mission, the South Carolina Emergency Management Division:

- Develops plans and procedures to ensure the highest levels of mitigation, preparedness, response, and recovery.

- Maintains a comprehensive, risked-based, multi-hazard emergency management and training program.

- Coordinates federal, state, and local resources for mitigation, preparedness, response and recovery operations.

SCEMD 2008 Disaster Recovery Plan Mission Statement

The mission of the federal, State, and local governments, as well as private disaster relief organizations in disaster recovery operations, is to provide immediate assistance to reduce or relieve human suffering and support the restoration of essential services. The State will coordinate and direct those operations when local government resources are inadequate or exhausted. The State will request and coordinate assistance from other states, the federal government, and private disaster relief organizations as necessary and appropriate.

Operational Objectives

In a post-disaster situation, the EMD has the following objectives:

- Facilitate local emergency management officials' survey and assessment of damage in their respective areas. Typically these activities are performed by county and/or city personnel with coordination provided by Regional Emergency Managers (REM) over an assigned number of municipalities.

- Collect timely and accurate damage assessment information, from REMs and other assigned damage assessment teams in the field.

- Assemble local initial damage assessment information into the format required by higher authority (e.g., Federal Emergency Management Administration, FEMA). Inspect for completeness and conformity to terminology, and accuracy of calculations where needed.

- Communicate the assembled data to higher authority to support decisions as to state or federal disaster declarations, and to support requests for federal disaster funding.

2. PROBLEM

2.1. Context

Natural and man-made disasters create situations of enormous complexity and demand urgent, focused management of damage assessment and recovery activities. Historical methods of collecting, collating, and communicating the data have consisted largely of on-site manual recording (e.g., clipboard and pencil), followed by collection of raw copy, manual typing of forms, and fax or courier delivery to the pertinent higher echelon. Additionally, photographs of damage sites have been incorporated only with extensive manual matching of images with the associated data elements.

As with all such manual data handling operations, not only is the process time and labor intensive, but accuracy and consistency can be seriously deficient due to human transcription error, awareness of detail, and the potential of lost or damaged paperwork. Gaps in field coverage, as well as the opposite – duplication due to multiple, non-coordinated surveyors – can further distort the critical data package.

Heretofore, response teams reported details on paper forms attached to clipboards. These forms were then transcribed into a MS Word™ file and/or Excel™ spreadsheet. This methodology facilitated numerous opportunities for error to be introduced into the resulting data. The time required for the data to reach its final format was also considerable and presented delays in resolving the post-disaster issues.

Emerging technology has produced systems and related operational procedures that vastly improve the quality of the collected and communicated body of data.

2.2. Acquisition Objective

The challenge of SCEMD was to acquire and implement a technical application to overcome the inefficiencies and inaccuracies inherent in manual post-disaster data management. The most important feature of a deployable solution would have to be simplicity of operation, affordablilty, and capablility of being implemented by members of related but diverse organizations over a wide geographical area.

Aside from accuracy, affordability, and expediency, it was essential to create a system that allowed users to be rapidly trained and facilitate simple, intuitive, and rapid information collection.

2.3. Selection of PinPoint-DisasterWorks^{tm} by SCEMD

Through contact at regional trade shows, a FEMA informational conference, and by word of mouth from existing municipal PinPoint customers such as city and county public works departments, SCEMD learned of the proposed PinPoint-DisasterWorks system and arranged for vendor demonstrations by PinPoint staff. It later established procurement criteria and issued a Request for Proposals via the South Carolina Procurement Division. PinPoint GeoTech, LLC, responded to the RFP and was the sole and successful proposer.

3. SOLUTION

3.1. Applications Overview

The PinPoint GeoTech suite of municipal applications originated as a system to automate the location and planning for the pickup of non-household municipal refuse: limbs, grass, furniture, construction debris, etc. Other GIS-dependent municipal applications such as locating street light outages, code violations, Americans with Disabilities Act (ADA) compliance issues, storm water management, signage problems, paving and drainage deficiencies, etc., quickly followed as implementing agencies discovered the broad range of flexibility of the system.

 Simultaneously, the immediate savings in vehicle fleet and manpower costs became apparent, producing impressive payback periods.

Following PinPoint's initial wave of implementation with over 50 public works and other municipal and engineering entities, applications were conceived for the use of the systems in post-disaster damage assessment and recovery planning.

This case study is based on field operations involving the Local Initial Damage Assessment and subsequent reporting phase of disaster recovery as is discussed in the South Carolina Emergency Operations Plan (SCEOP).

Other disaster management phases that have extremely compelling applications for this system are:

First Response (Life Preservation and Public Hazards)

Recovery and Cleanup

Audit

Commercial Work Order Tracking, Billing, and Audit

3.2. Technologies Employed

To accomplish this field-to-headquarters, occurrence-to-response process, PinPoint uses the following technologies;

- Ruggedized, hand-held, touch-screen enabled PDA units with:
    - o 2-meter and optional sub-meter GPS receiver
    - o Wi-Fi and optional GPRS/GSM data transmission
    - o USB Port
    - o Camera
    - o Microphone - Voice Note Recorder
- PinPoint Disaster Works[tm] Touch Activated GPS (TAG) PDA Software
- Integrated SQL database containing GIS Parcel Tables
- Optional Shape File Viewer software

Key Components

- TAG Unit Field Hardware:
- Trimble Juno SB Ruggedized Handheld PDA, Camera, BlueTooth, WiFi, Vehicle Mount, AC/DC Charging Cables, USB Cable, Otter Box Protective Case, Belt Clip Holder
- Optional Juno SC (same as above but with GPRS-Cellular Data Transfer capability; also requires cell service data plan

- Other optional MS Windows Mobile™ PDA Platforms with Mil-Spec ratings, embedded options such as RFID Reader, Barcode Reader, and Bluetooth Device interfaces

- PinPoint Public Works[tm] Management Console/Server

    The Management Console Server operates as a "control tower" for incoming and outgoing data to and from the TAG Units.

The primary function of the Management console is to accept incoming data from the TAG Units in the field and parse the data into the shared databases on a server, laptop or desktop computer for use by the users of the DeskTop Mapping Application.

The Management Console also has other back-end functionality that allows for instant notification via e-mail and SMS Text messaging as data from certain buttons comes into the system.

Finally, it allows for the update, backup, and statistics reporting functions to be automated.

- o Multi-Unit Remote TAG Seat License Manager
- o Can reside on server, or stand-alone Desktop PC, or Field Laptop

- PinPoint Desktop Mapping Application
  (includes Microsoft MapPoint CAL)
  - o Mapped Display of Field Data
  - o Sort / Filter Data Query Engine
  - o Simple Work Order Creation
  - o Basic Reporting Module
  - o MS Office interoperability:
    - MS Word Template Automated Population
    - MS Excel Template Automated Population
    - Data export to CSV, TXT, XML Files
  - o Export to ESRI, & various Routing Software and Asset/Work Order Management Systems
  - o Export to Google & Garmin mapping and GPS formats
  - o TAG Unit Button Profile Management Module
  - o Mapping Icon Customization Module
  - o Installation and Training

- TAG Unit Custom Data Entry Screens

See Sample Operator Work Flow, Section 4.4, below

- Additional Customization or Specialized Training
- Custom Report Generation
- Data Integration with Existing Systems

Integration with Other Systems

> To ensure that observed damage to a structure is identified to that exact structure, and to protect against ambiguity resulting from the observer (and the TAG unit) being offset from the precise damage location, the system relies on GIS Parcel data from local tax databases and ESRI Layered Shape Files.

> Working with the SCEMD, PinPoint GeoTech obtains official access to GIS resources which normally are the property of and controlled by local county or municipal agencies.

4. APPLICATION TO THE SCEMD PROBLEM

4.1. Organizational Structure

> The SCEMD, similar to many other state EMD organizations, is primarily a central coordinating agency, accomplishing the timely, accurate, and consistent collection and forwarding of post-disaster damage assessment data to agencies charged with on-the-ground recovery operations. These agencies include both public organizations (e.g., National Guard, local law enforcement), and private ones (e.g., American Red Cross and church-based).

> Assessment data also is passed upward to federal agencies within the Homeland Security Department, notably the Federal Emergency Management Agency (FEMA). The latter path is central to federal declarations of disaster areas and the consequent eligibility of those areas for federal funding and assistance-in-kind.

> This (EMD) structure and function dictated the introduction of PinPoint-DisasterWorks™ at the state level. There the system was tailored to the creation of a data set and workflow methodology that would ensure accurate and complete post-disaster coverage for upward transmission, simultaneously ensuring that local assessment teams would find the system understandable and easy to use.

> In South Carolina, assessment surveys are conducted by agencies of the 46 counties operating under the coordination of thirteen Regional Emergency Managers (REM) who respond to the SCEMD. In special cases, personnel from the state, city, and/or county level assist with, or conduct, the damage assessment functions.

4.2. System Functionality

> Initial implementation consisted of (1) Analyzing current best practices with regard to the manual method of collecting post disaster damage assessments, (2) identifying the specific elements of assessment information needed for upward transmission, (3) identifying the reporting formats required, and (4) enlisting the help of the REM's in evaluating the preliminary structure of the implementation model and the functionality of the system in the field.

*Field Data Collection:

The basic implementation module consists of a number of hand-held "TAG" units for use by the field damage assessment teams. Each TAG unit is programmed to communicate wirelessly via either a WiFi or GPRS/GSM (with a Cell Data Plan) access point with connectivity to a localized field-hardened laptop computer or an aggregation computer located at the state EOC. The Management Console Software module, located on a server or desktop/laptop aggregation computer, collects all field data and posts it into a database system yielding a coherent block of data.

*Data Aggregation and Presentation:

In the case of localized laptop aggregation points, the data is ultimately transmitted by means of the established disaster communication network to the Emergency Operations Center (EOC) in Columbia where it is further aggregated and made available for mapped and formatted display to the EOC operational staff, headed by the EMD Director, the Adjutant General, and/or the Governor.

These officials are able to call up text, voice, and photographic information from any affected area, enabling them to deploy ground relief forces, to assess the probable future course of the situation, and to formulate requests for assistance from neighboring states or the Federal Government.

The basic software package is customized to produce output data in report formats required by local and federal agencies, thus eliminating the need for hand collating and manual transcription of incoming data.

*Team Tracking and Coverage Mapping:
The data mapping application enables EOC-level managers to ascertain that all sectors of the disaster area have been covered. The system's "breadcrumb" feature provides a time-scaled track of each assessment team's travel.

*Situational Awareness:
Geographic representation of the totality of disaster related issues allows efficient assigning of work crews, response teams, and other mitigation forces by geographic zones to eliminate random operations and issue resolution and the inefficiencies inherent within.

* Reporting, Export, Interoperability, Data Interchange:

Available formats include Microsoft Word, Excel, & MapPoint as well as XML, CSV, ESRI Polyline and Point Shape files. In addition to producing tabulated data, PinPoint can overlay on the recorded data points (situation, latitude, longitude, date, time, attribute, asset/parcel, and ancillary photographic, text, or voice notes) to area maps and export files for use by recovery forces in rapidly and accurately deploying to the locations in need of help.

Disaster assessment data is dependent on accurate portrayal of damage in two main respects: (1) location of the damage, and (2) its physical extent, from which cost estimates are generated.

The system enables field assessment teams to record quantitative measurements of damage, such as cubic yards of debris, areas of destroyed roadway, etc., and to "pinpoint" their specific locations to facilitate recovery team operations and field audit of reported damage.

Precise location and identification of damaged areas/structures can be essential to processes involving compensation of some form, such as insurance claims. Locations may need to be verified against official, initial damage assessments.

4.3. Project Implementation Process

The SCEMD investigated the opportunities and initiated contractual procurement of the system. Prior to this procurement, the system was programmed with disaster recovery profiles representing generic categories of damage for various types of disasters: e.g., collapsed structures, road washouts, power lines down, roofs destroyed, etc. Immediately upon the procurement of the system, SCEMD and PinPoint GeoTech established a process to refine the data categories and functions needed for field data collection, to fit local experience in different types of disasters. Appendix B contains images of selected profiles.

An initial demonstration was held with the SCEMD staff and a representative number of Regional Emergency Managers (REMs). The interactive session identified several features and operational issues that needed to be accommodated within the TAG unit software functions. These included:

Team and Event Detail Entry

Damage Assessment Case Identification

Categorization of Case as Individual, Business, or Public Facility

Marking of critical services needed at assessment location

Police, Fire, Rescue, Utility, etc.

Other Features:

> Screen Locking
> Suspension of Breadcrumb Tracking (during breaks)
> In-Field Assessment Reports and Case Review
> On-Button Visual Notification of Assessed Sub-Items

Subsequent sessions included all of the REMs, who were deployed in teams to various sections of the immediate area (greater Columbia, South Carolina) to use the PinPoint TAG units and simulate damage assessment items within their assigned practice areas. Upon their return from the field simulation routes, their results were displayed in map form as well as the tabulation of their data onto the FEMA Local Initial Damage Assessment (LIDA) forms. Participant reaction was extremely positive, with several suggestions for improvement of the profiles, such as provision for short interruptions (lunch breaks, etc.) in an assessment session, changes to the makeup of the assessment team, provision for accounting for central debris collection points, etc. Some of the improvement suggestions were accommodated during the critique session itself, while those requiring more extensive programming and testing were deferred for later accomplishment.
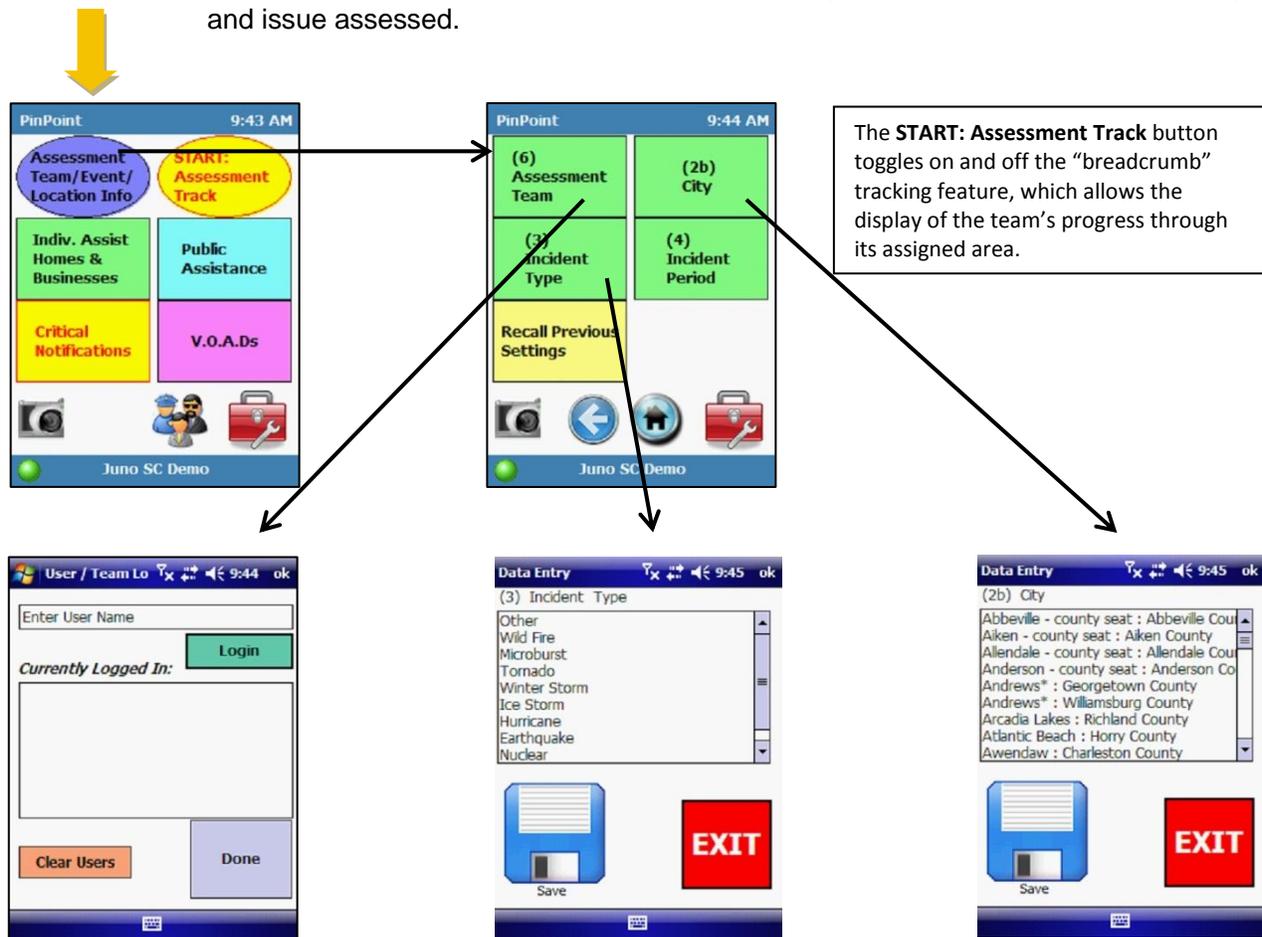
Ongoing dialogue between PinPoint staff and SCEMD managers pursued the suggested improvements to completion. This was followed by provision of TAG units to the REMs for continued practice in their home areas. As always, operational critique and suggestions for continuous improvement were strongly encouraged from the REMs. These field tests produced valid suggestions for functional and human-factors improvements.

4.4. Sample Operator Workflow

4.4.1. Event Setup

At the beginning of an Assessment Track through an assigned area, the assessment team would typically use the Assessment Team Login screen and other event identification buttons to record the team makeup, the city and county, and the type and time period of the disaster event. Drop-down lists for City and Incident Type ensure consistency of terminology among multiple teams.

This information is stored in the TAG unit's memory and is recalled for each property and issue assessed.

The **START: Assessment Track** button toggles on and off the "breadcrumb" tracking feature, which allows the display of the team's progress through its assigned area.

- Keyboard icons at the bottom of selected screens activate stylus-operated keyboards for text entry.

- Numbers in parentheses correspond to column numbers on FEMA LIDA forms.

- Should the team encounter a situation demanding immediate attention by relief entities (fire, police, utilities, shelter, food bank, etc.), the **Critical Notifications** button invokes follow-on screens for each particular type of assistance needed. The TAG unit transmits this information directly to the EOC to facilitate immediate dispatch of appropriate units.

- **V.O.A.D.S.** button _____

4.4.2. Initial Damage Assessment – Private Sector

Following the Event Setup phase, the team selects either **Individual Assist Homes & Businesses** or **Public Assistance**, depending on the damage site encountered. Here, "Public" refers only to government-owned facilities.

The **START: Occupant** button invokes a text entry screen for recording the owner or other identifying information considered necessary ro avoid confusion in identifying a property. Activation of the other buttons in sequence brings up the follow-up screens shown.

Place holder for button 28, SBA status.
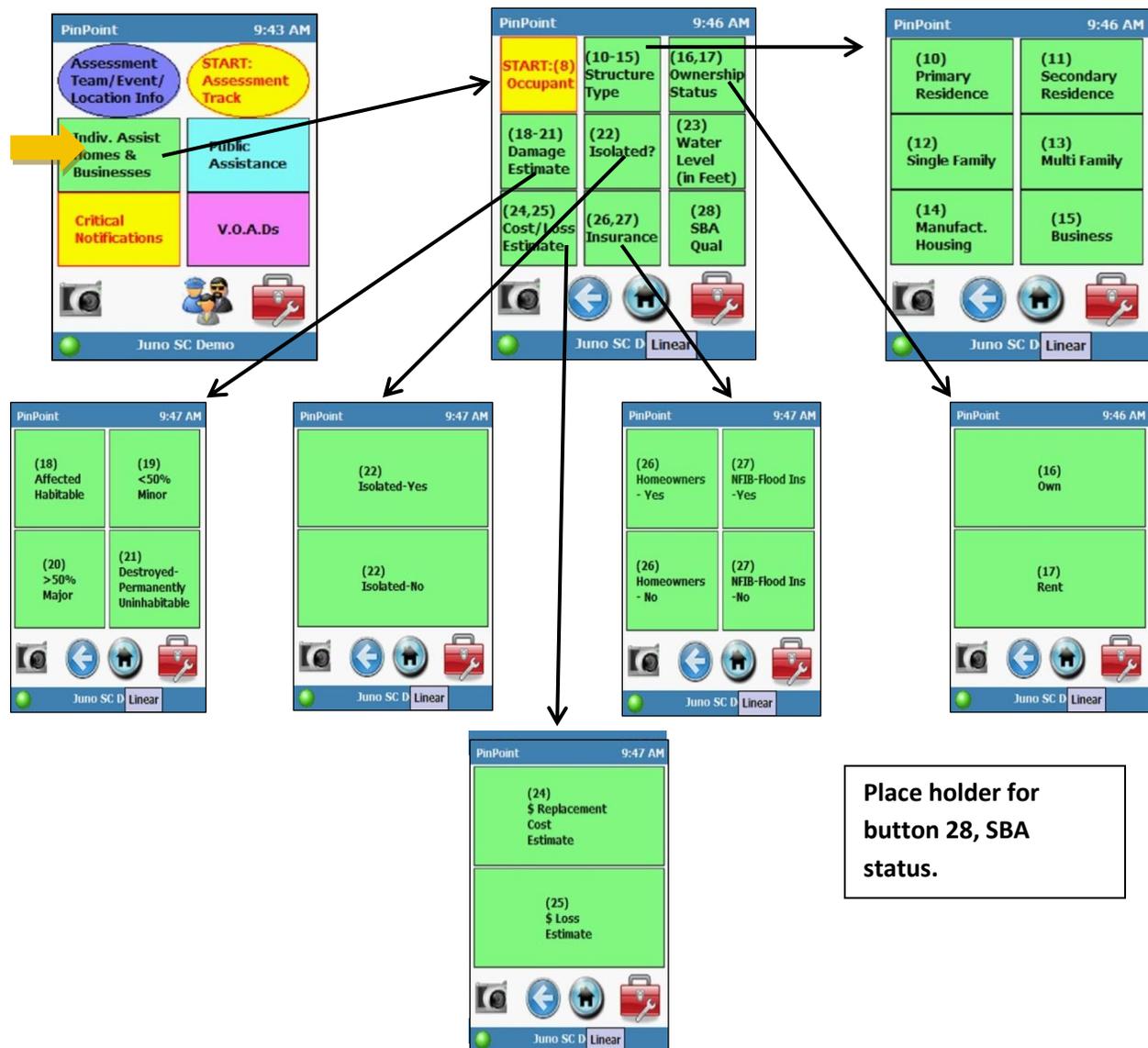
4.4.3.   Initial Damage Assessment – Public Sector

The team uses the Public Assistance button to bring up similar screens for recording of detailed information on public infrastructure damage. As with the button labels for private property assessments, the numbers on the Public buttons correspond to columns on the FEMA Public LIDA Supplement document, distinguished by a prefixed "P".

Each of these buttons invokes drill-down buttons for recording further levels of detail, as with the Private Sector set.
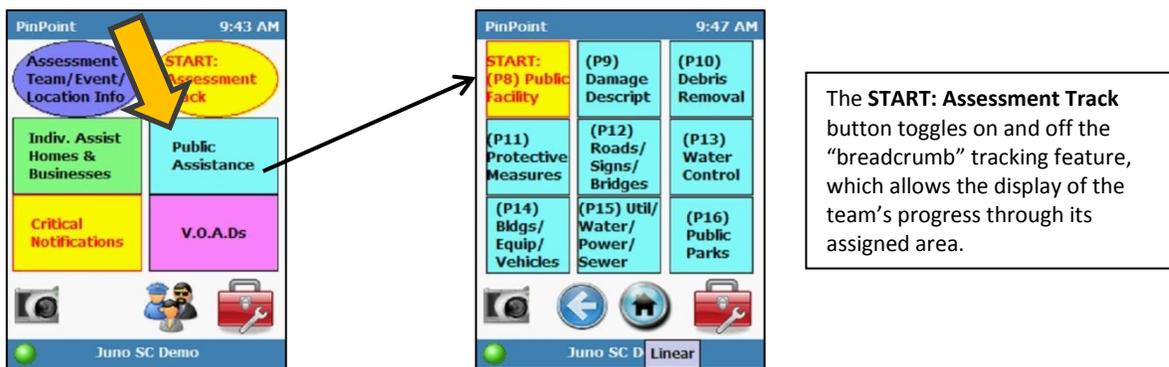
The **START: Assessment Track** button toggles on and off the "breadcrumb" tracking feature, which allows the display of the team's progress through its assigned area.

4.4.4.   Other Features

Integral calculator for on-site calculation nof areas, volumes, cost estimates and other quantitative information.

Text entry screen. Keyboard icon at bottom mopens a stylus-activated keyboard foentering text data.

Buttons to expand selection of **Critical Notifications** button on opening screen.

5. Operational Testing

An operational test of the PinPoint system was conducted by SCEMD staff, assisted by three REM's and by PinPoint GeoTech staff.

The test objective was to obtain comparative data between the historical method of conducting a damage assessment and the use of the PinPoint system. Data were collected on the time, accuracy, and level of effort required by the two methods.

Appendix D provides a summary report of that test.

6. Future Action

In the future, periodic software revisions will aggregate ongoing minor changes. Major changes, affecting the basic utility of the system will be issued on an ad hoc basis.

It is planned to encourage each county and municipality having emergency management responsibilities to procure PinPoint units and to integrate them into the SCEMD system.

A factor of great value to local agencies is the ability to employ the PinPoint system for routine, non-disaster-related operations such debris pickup, codes enforcement, and asset management, and be able to change the application profiles to Disaster Recovery Data Collection instantaneously in the event of a disaster.

7. EVALUATION

- General Project Assessment

  PinPoint GeoTech's SCEMD experience is evidence of its commitment to tailoring its systems to the operational processes of its clients, from organizational levels to the hands-on field operators. Every effort is made to debug the system profiles immediately upon report of a problem, and to proactively improve factors involving the human interfaces.

- Our observation of the results of the SCEMD adoption of the PinPoint system is that significant improvements are achieved in the speed and functionality of post-disaster damage assessment.

- Lessons Learned

  In the post-disaster area of application, as in its numerous other applications, the PinPoint system is demonstrably

    Simple – easy to train; intuitive; customizable by user

    Affordable – modular procurement enables low initial investment with later expansion as application areas emerge, etc.

    Effective - produces end-product, formatted data that is required by higher management and is readily available for submission.

APPENDICES

Appendix A

List of Abbreviations

ADA	Americans with Disabilities Act
EMD, SCEMD	Emergency Management Division
EOC	Emergency Operations Center
EOP, SCEOP	Emergency Operations Plan
ESRI	Environmental Systems Research Institute
FEMA	Federal Emergency Management Administration
GIS	Geographic Information System
GPRS/GSM	General Packet Radio Service / Global Systems for Mobile (communication)
GPS	Global Positioning System
LIDA	Local Initial Damage Assessment (form)
PDA	Personal Data Assistant
REM	Regional Emergency Manager
RFID	Radio Frequency Identification Device
TAG	Touch-Activated GPS (unit)
USB	Universal Serial Bus
VOADs	Volunteer Organizations Active in Disasters

Appendix B

Local Initial Damage Assessment Form – Individual and Business

Data is collected by field operators via the PinPoint TAG units and is recorded automatically at the EOC into a spreadsheet format used to forward assessment data to FEMA and/or other higher echelons. The spreadsheet cells and columns are headed as shown below. The cell/column numbers in parentheses are reflected by the same numbers on the TAG unit touch-screen buttons.

(1)   Page number

(2)   (a) County   (b) Municipality

(3)   Incident Type

(4)   Incident Period

(5)   Date of Survey

(6)   Assessment Team Members

(7)   Phone Numbers

(8)   Occupant/ Business Name, If Known

(9)   Physical Address / GPS Coordinates

(10   Home, Primary

(11)   Home, Secondary

(12)   Structure, Single Family

(13)   Structure, Multi-Family

(14)   Structure, Manufactured Housing

(15)   Structure, Business

(16)   Status: Own

(17)   Status: Rent

(18)   Damage: Affected

(19)   Damage <$50K, Minor

(20)   Damage >$50K, Major

(21)   Destroyed

(22)   Isolated? Y/N

(23)   Water Level in Structure

(24)   Replacement Cost

(25   Estimated Dollar Loss

(26)   Insurance: Homeowners

(27)   Insurance: National Flood Insurance Program (NFIP)

(28)   Meets SBA Criteria: Y/N

Appendix C

Local Initial Damage Assessment Form – Public Asistance

Assessment data for public facilities (public buildings, parks, infrastructure, etc.) is collected in the same manner as for Homes and Businesses. A single session/track can include a mixture of homes, businesses, and public assistance assessments, with the TAG unit readily convertible from one LIDA form category to the other by a simple button-press by the operator. The report spreadsheet cells and columns, reflected by the numbers on the touch screen, are as follows;

(1) through (7) Same headings as for Homes and Businesses

(8)   Name/Location (Physical Address)

(9)   Description of Damage

(10)   Emergency Work: A - Debris Removal

(11)   Emergency Work: B - Protective Measures

(12)   Permanent Restoration: C - Roads, Signs, Bridges

(13)   Permanent Restoration: D – Water Control

(14)   Permanent Restoration: E – Buildings and Equipment

(15)   Permanent Restoration: F – Public Utilities

(16)   Permanent Restoration: G – Parks, Recreation, and Other

(17)   Total Estimated Damages in Dollars