

LANDFILL GAS EXTRACTION SYSTEM EVALUATION USING ARCGIS

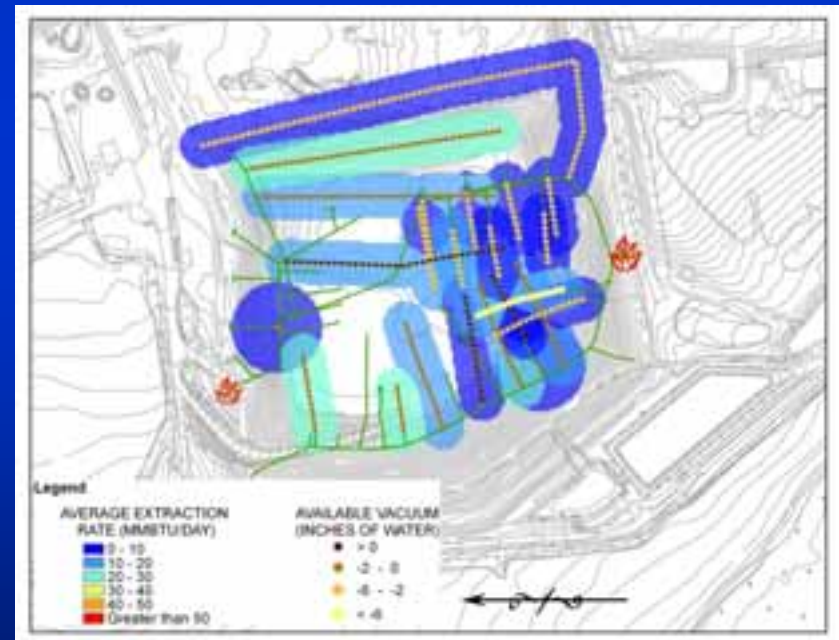
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OUTLINE

- Landfill Gas 101
- Landfill Gas Extraction Systems & System Maintenance
- Data Evaluation
- ArcGIS Applications
- Work Flow
- GIS Methods
- Next Steps
- Acknowledgements



LANDFILL GAS (LFG) 101

- Generated from the biological decomposition of waste
- General composition:
 - ~50% methane
 - ~45% CO₂
 - ~5% other
- Potential issues if LFG is allowed to build up in a landfill:
 - Fire hazards
 - Odor
 - Off-site migration (in older, unlined landfills)



LFG EXTRACTION SYSTEMS

Horizontal
Extraction Trench



Vertical
Extraction Well



LFG EXTRACTION SYSTEMS (CONT.)



What happens to the gas?

- Utilized in LFG-to-energy facility
- Burned at a flare



SYSTEM MAINTENANCE

- Multiple parameters measured at each extraction well & trench
- System adjusted accordingly
- Data collected weekly



DATA EVALUATION

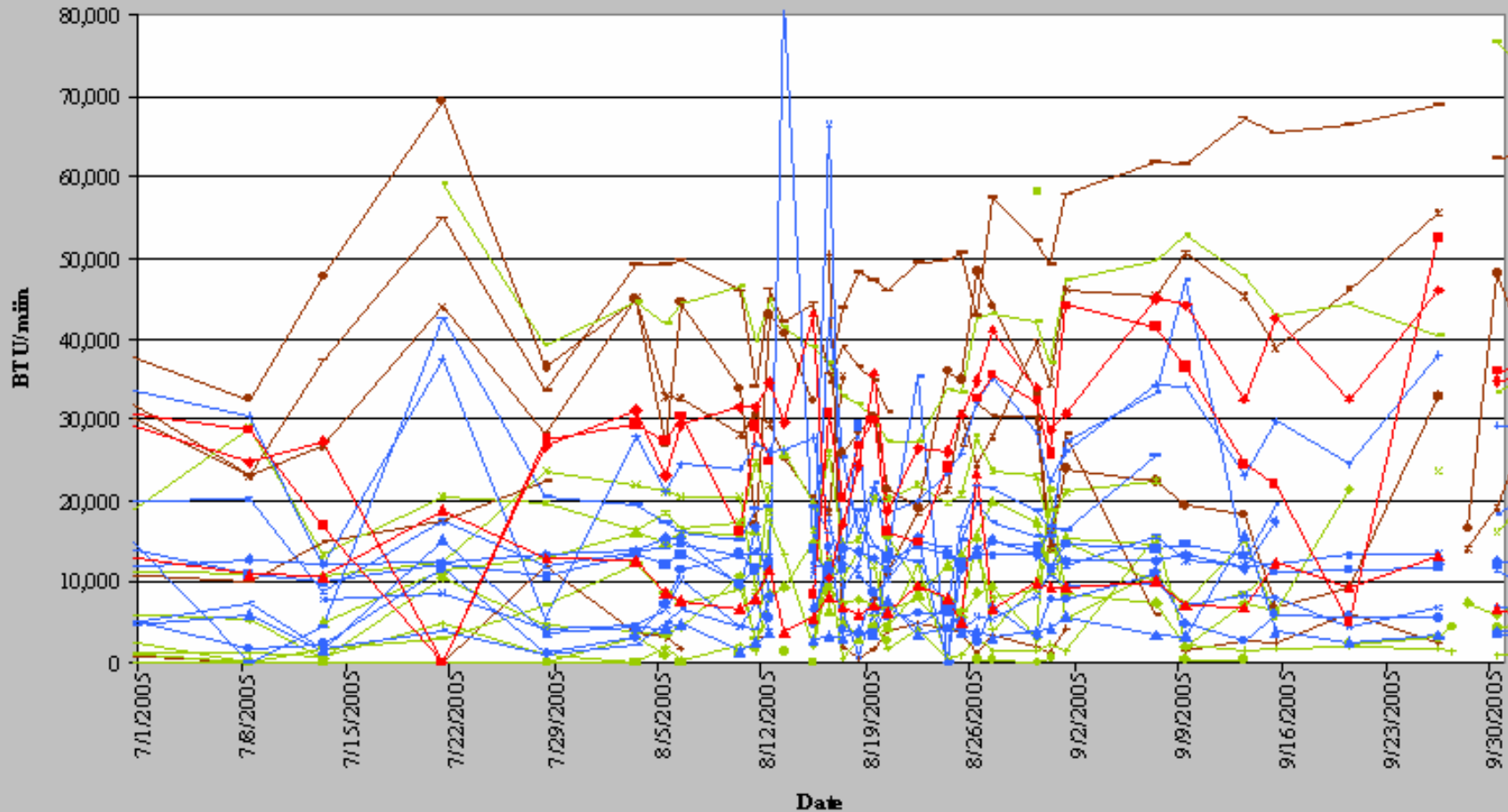
$$\text{Energy} = \frac{\text{CH}_4\%}{100} \times \text{CH}_4 \text{ Heat Content} \times Q \times 1.44 \times 10^3$$

Where:

- Energy is extraction rate in MMBtu/day
- CH₄% = Percent methane measured at extraction point or control device
- CH₄ Heat Content = 1,000 Btu/ft³
- Q = Landfill gas flowrate in ft³/min

DATA EVALUATION (CONT.)

Extraction Well BTU Content

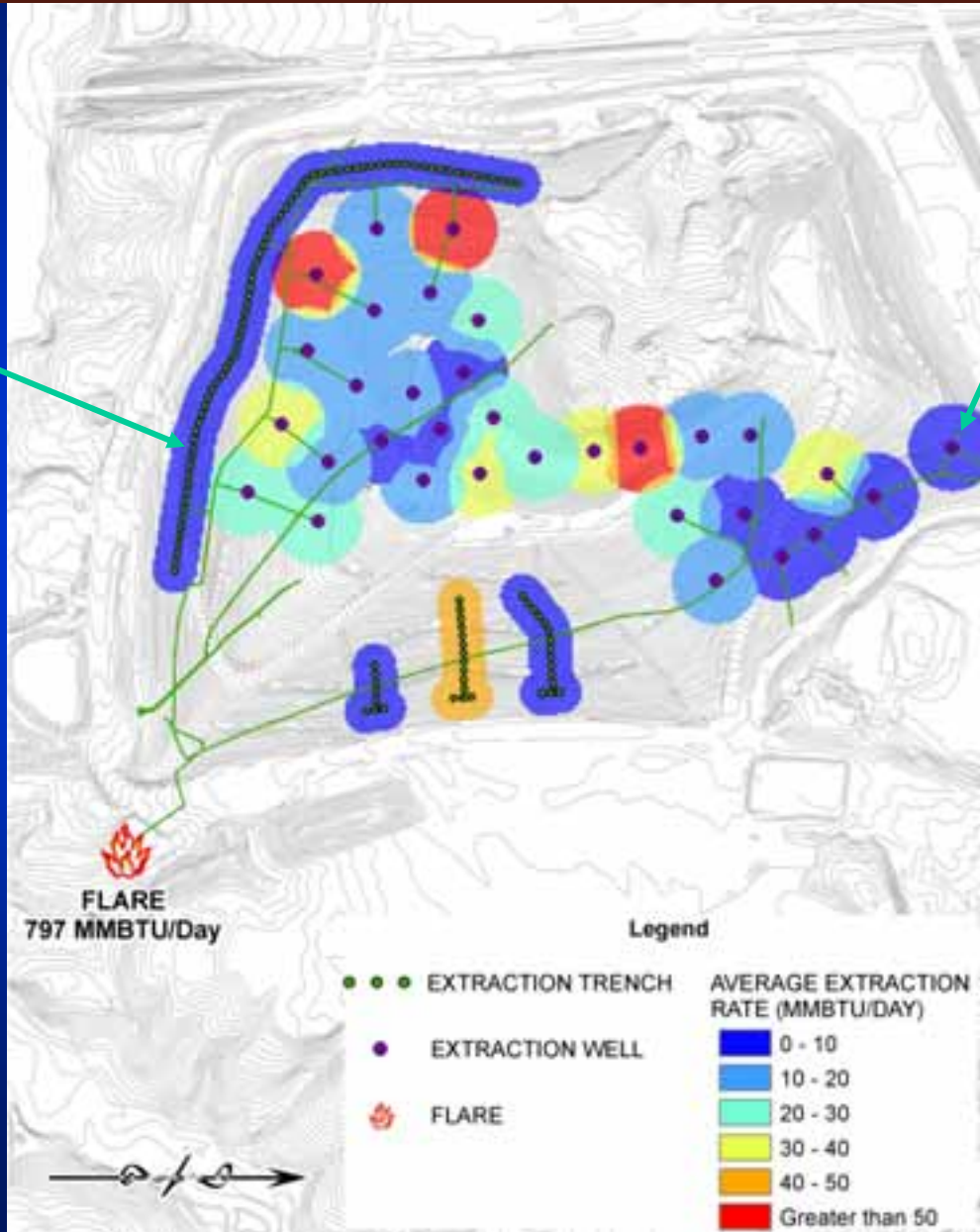


- | | | | | | | | | |
|-------|-------|--------|--------|--------|-------|--------|-------|-------|
| GW-33 | GW-32 | GW-22 | GW-20B | GW-20A | GW-20 | GW-19A | GW-18 | GW-17 |
| GW-16 | GW-15 | GW-10B | GW-10A | GW-10 | GW-9A | GW-9 | GW-8A | GW-8 |
| GW-7A | GW-7 | GW-6 | GW-5 | GW-4 | GW-3 | GW-2 | GW-1 | |

DATA VISUALIZATION USING GIS

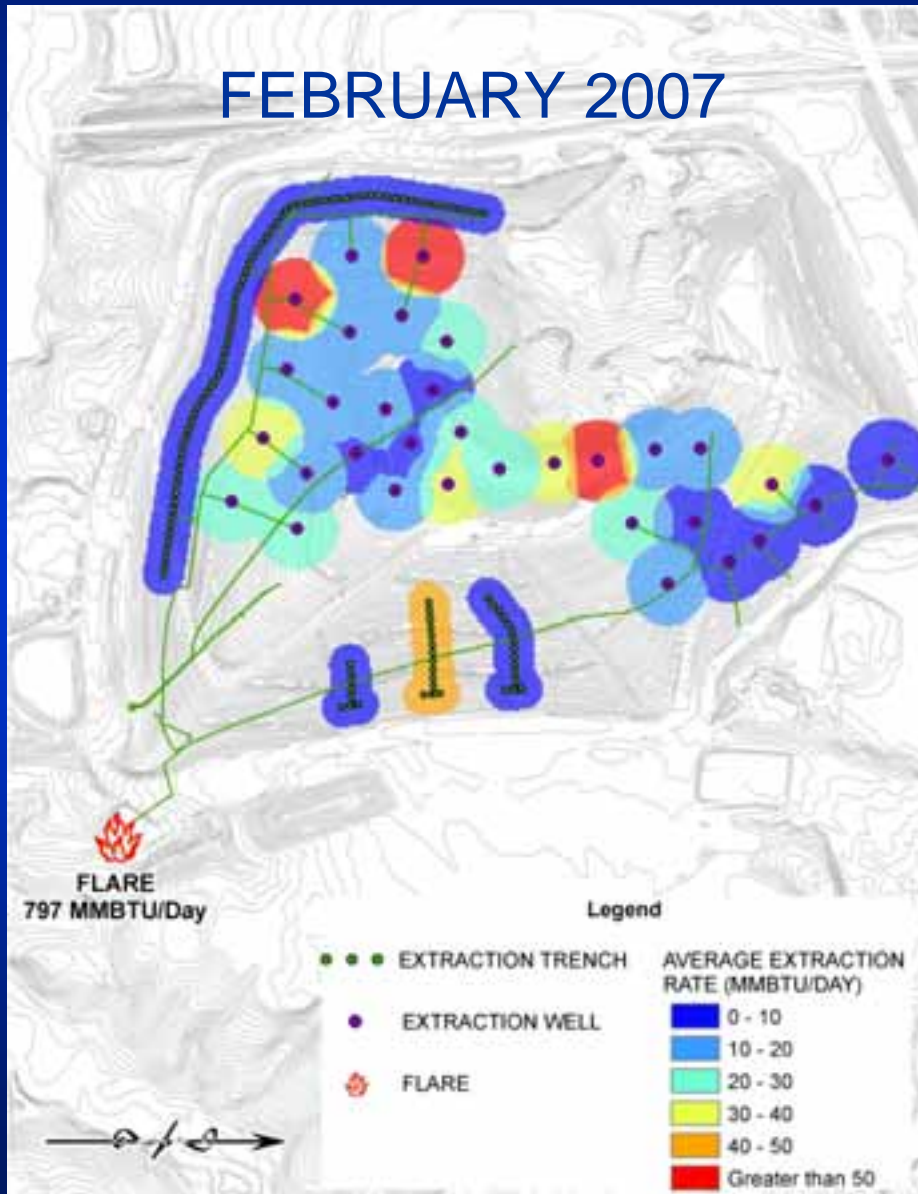
Trenches: 50-ft
radius of influence

Wells: 100-ft
radius of influence

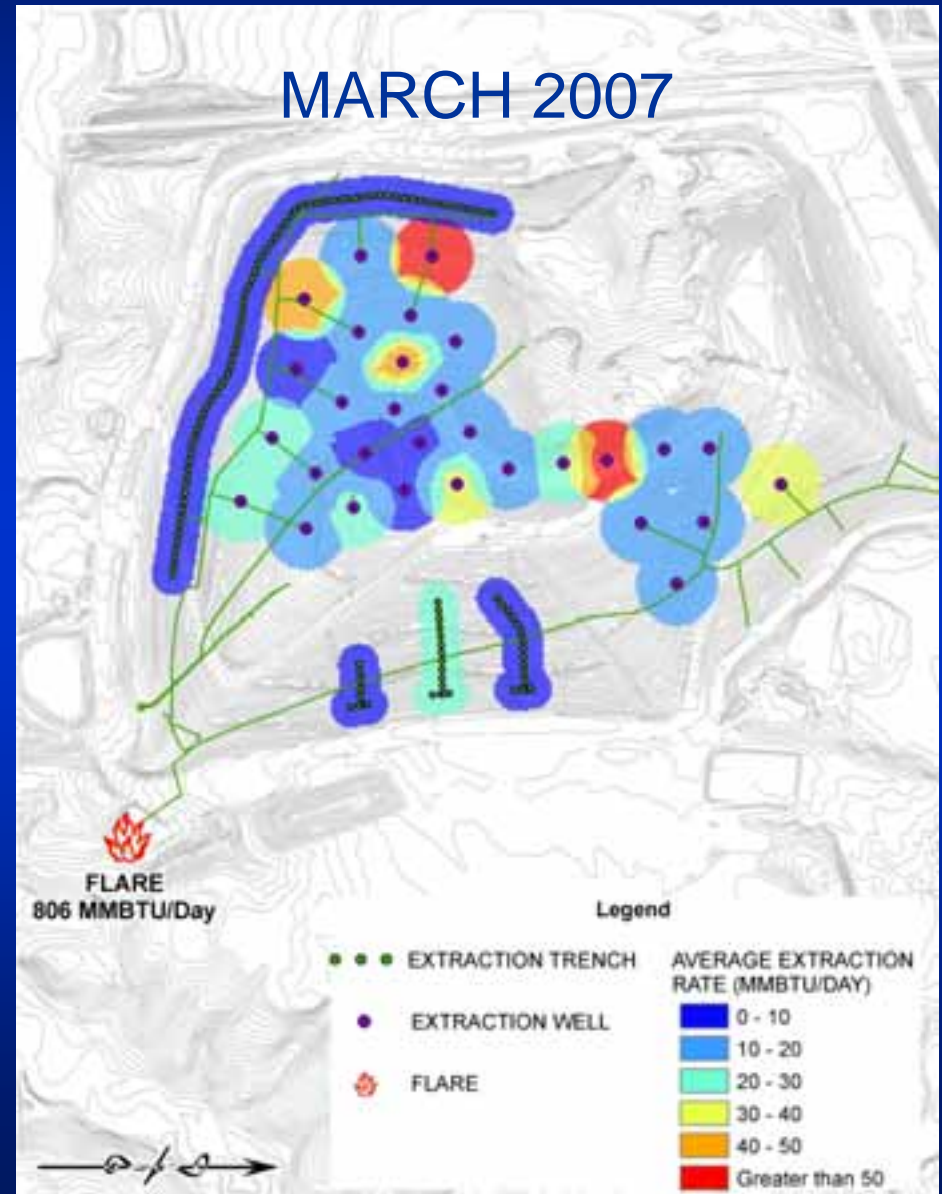


MONTHLY COMPARISON

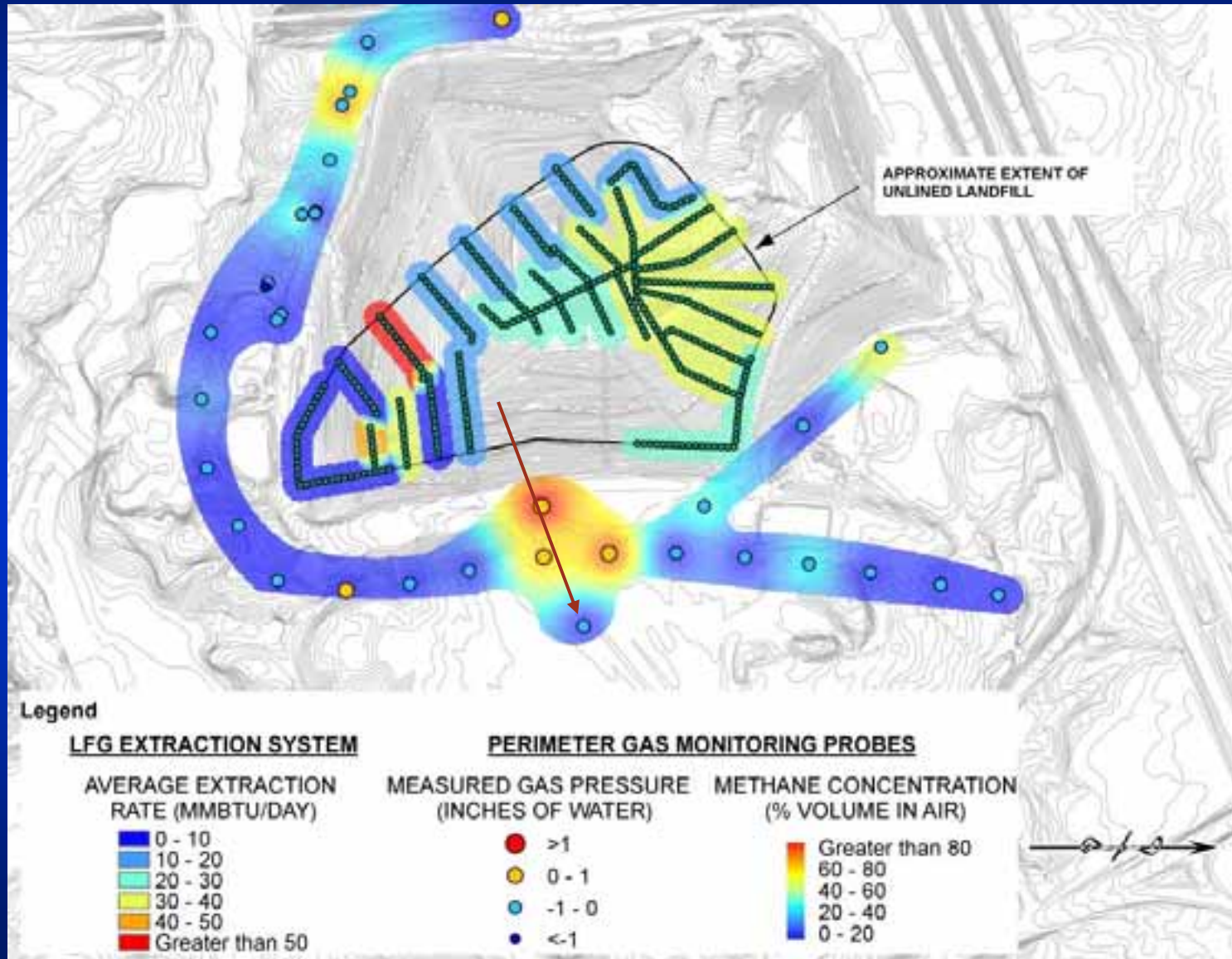
FEBRUARY 2007



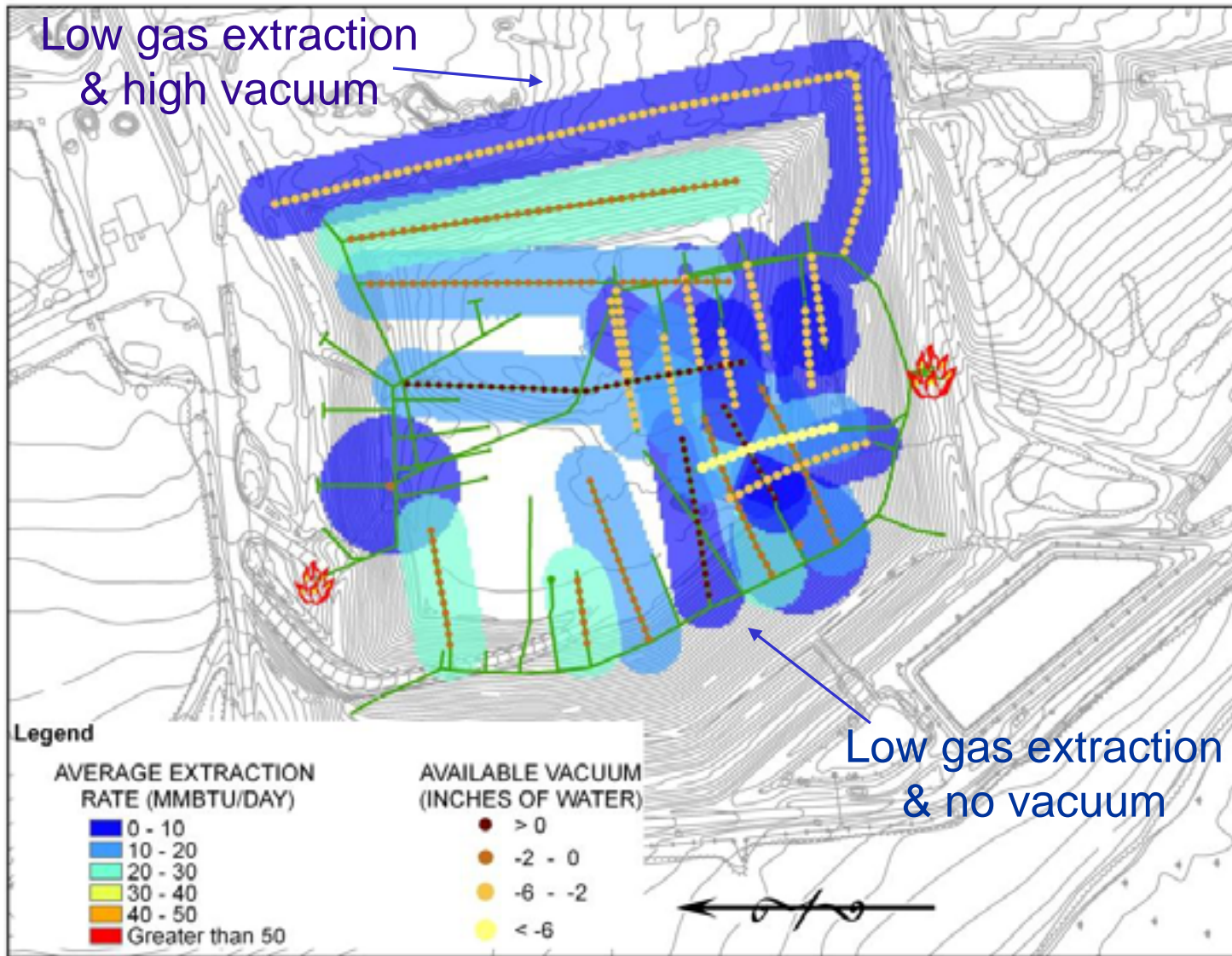
MARCH 2007



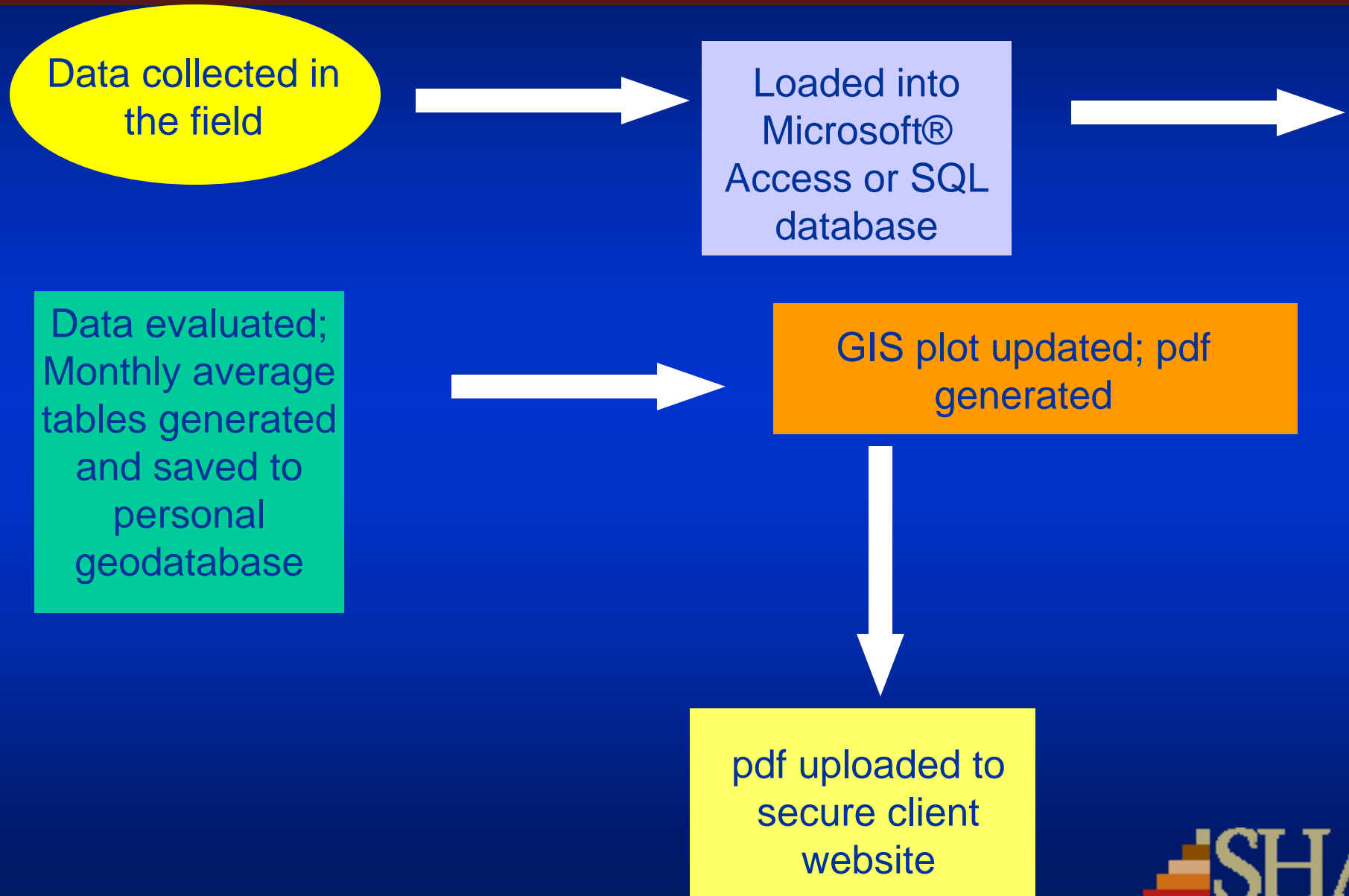
OFF-SITE MIGRATION



EVALUATE MULTIPLE DATA SETS



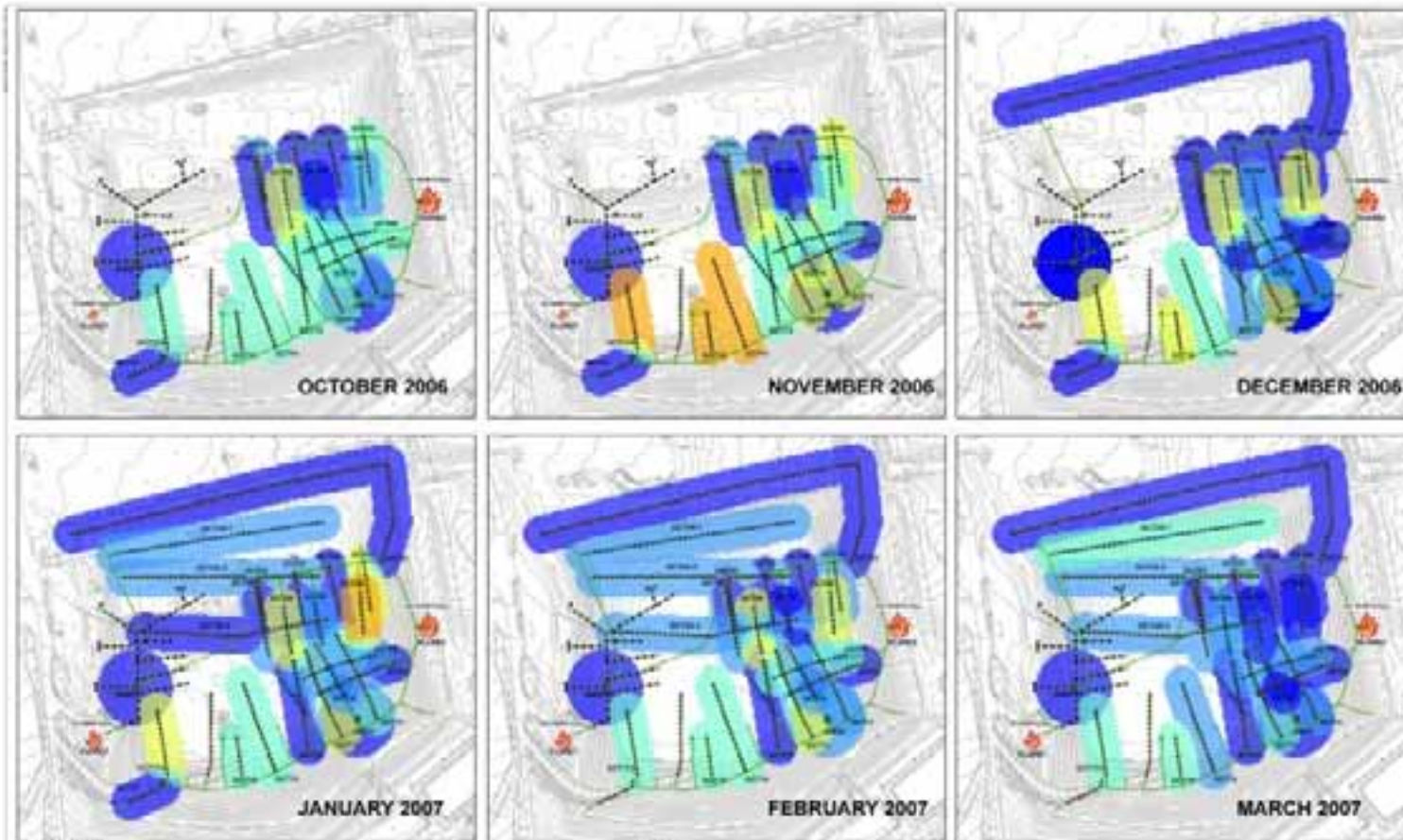
WORK FLOW



WORK FLOW (CONT.)

The screenshot shows a web browser window titled "Client Services - Home Page - Microsoft Internet Explorer". The address bar displays "http://clients.sanbornhead.com/000". The page content includes the SHA logo (Engineers & Scientists) in the top left, a "Main Menu" with buttons for "Home", "View Files", and "SHA Website", and a "Client Login Page" section. The login section features a grey box with "User name:" and "Password:" labels, each followed by a white input field, and a "Sign In" button below them. The text "Please Enter your user name and password to access additional data" is positioned above the input fields. The browser's taskbar at the bottom shows several open applications, including "D:\...", "C:\WINDOWS\...", "C:\CONCAT\...", "C:\...", "Sanborn, Head & Associates", and "Client Services - Home Pa...".

WORK FLOW (CONT.)



Legend

AVERAGE DAILY ENERGY EXTRACTION RATE AT FLARE

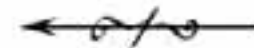
- LFG EXTRACTION WELLS
- UPPER LFG EXTRACTION TRENCHES
- LOWER LFG EXTRACTION TRENCHES
- LFG HEADER PIPES

AVERAGE LFG EXTRACTION RATE (MMBTU/DAY)

- 0 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- Greater than 50

Notes

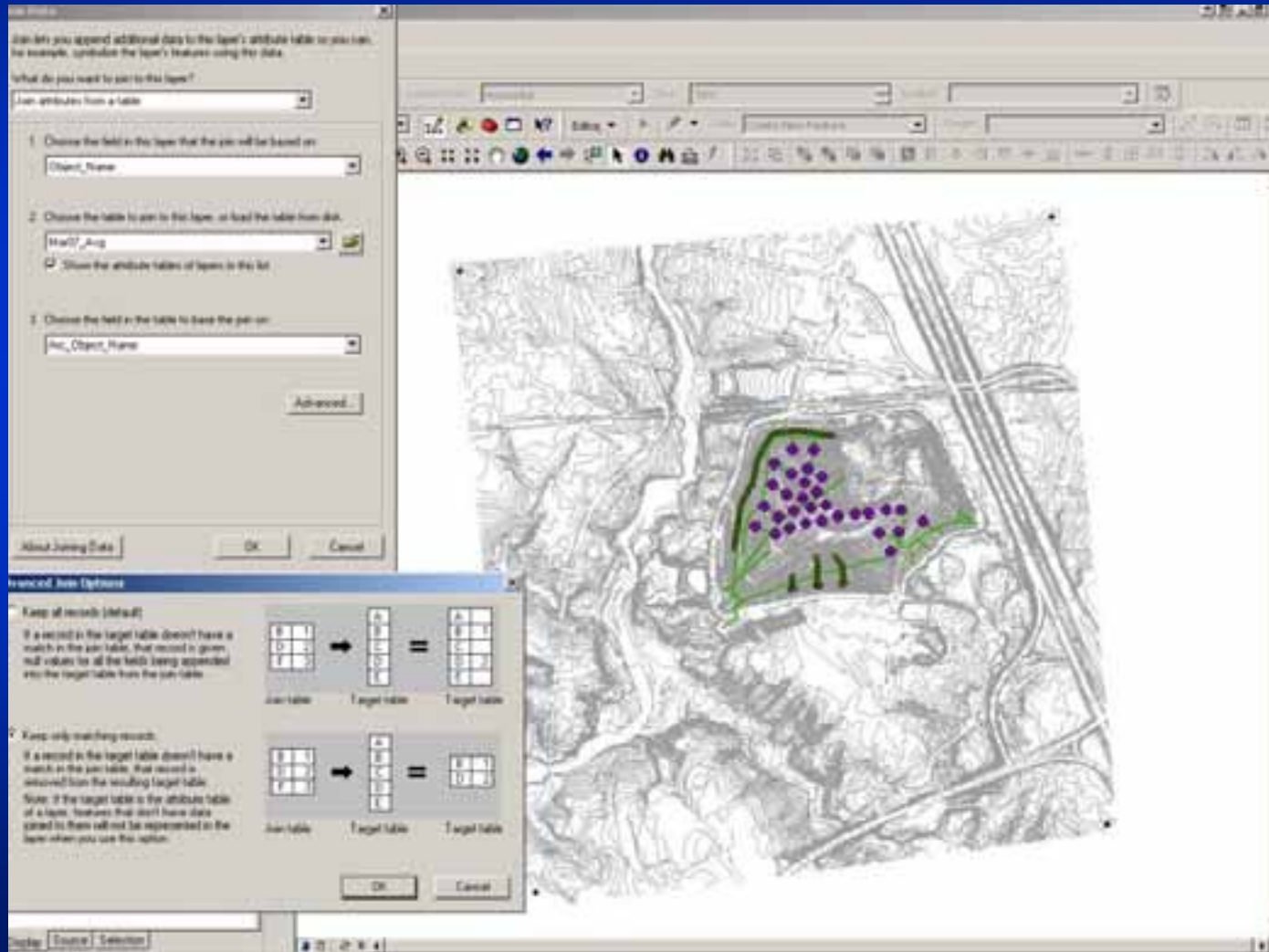
1. The final map was developed based on design and detailed construction guidelines for System. Heat is recovered and 100% landfill gas (LFG) landfill information was provided to the City of San Francisco. The final map was developed based on the design and construction of the final layout of the LFG extraction system. Information was provided to the City of San Francisco.
2. This map is intended to provide average monthly LFG energy extraction rates. It is not intended to provide a detailed design or construction plan. It is intended to provide a general overview of the system. Actual conditions may vary from the information and data represented on this map.



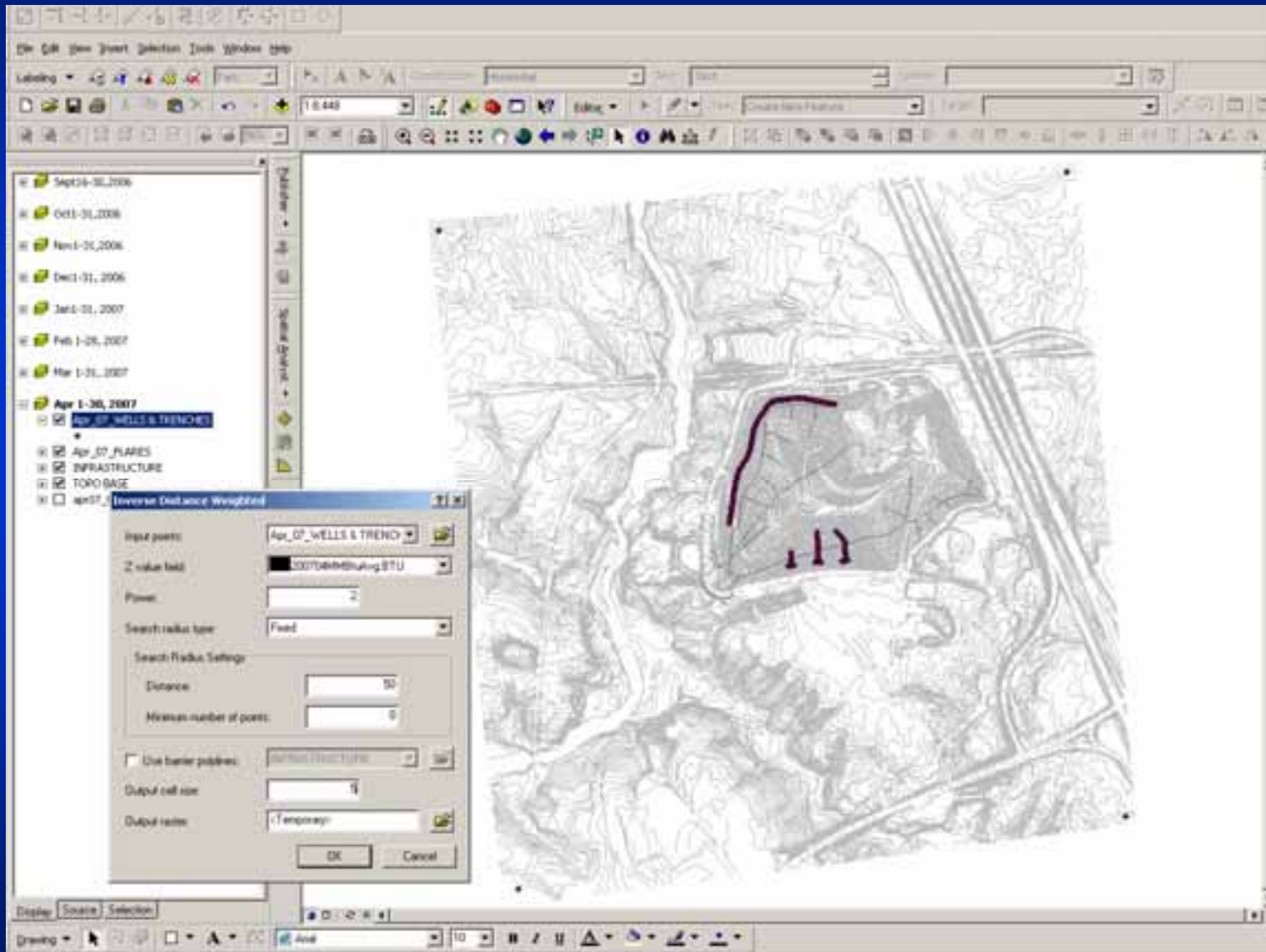
PROGRESS PRINT
04/30/07

LFG EXTRACTION SYSTEM
 LANDFILL X
 LANDFILL GAS EXTRACTION
 SYSTEM EVALUATION

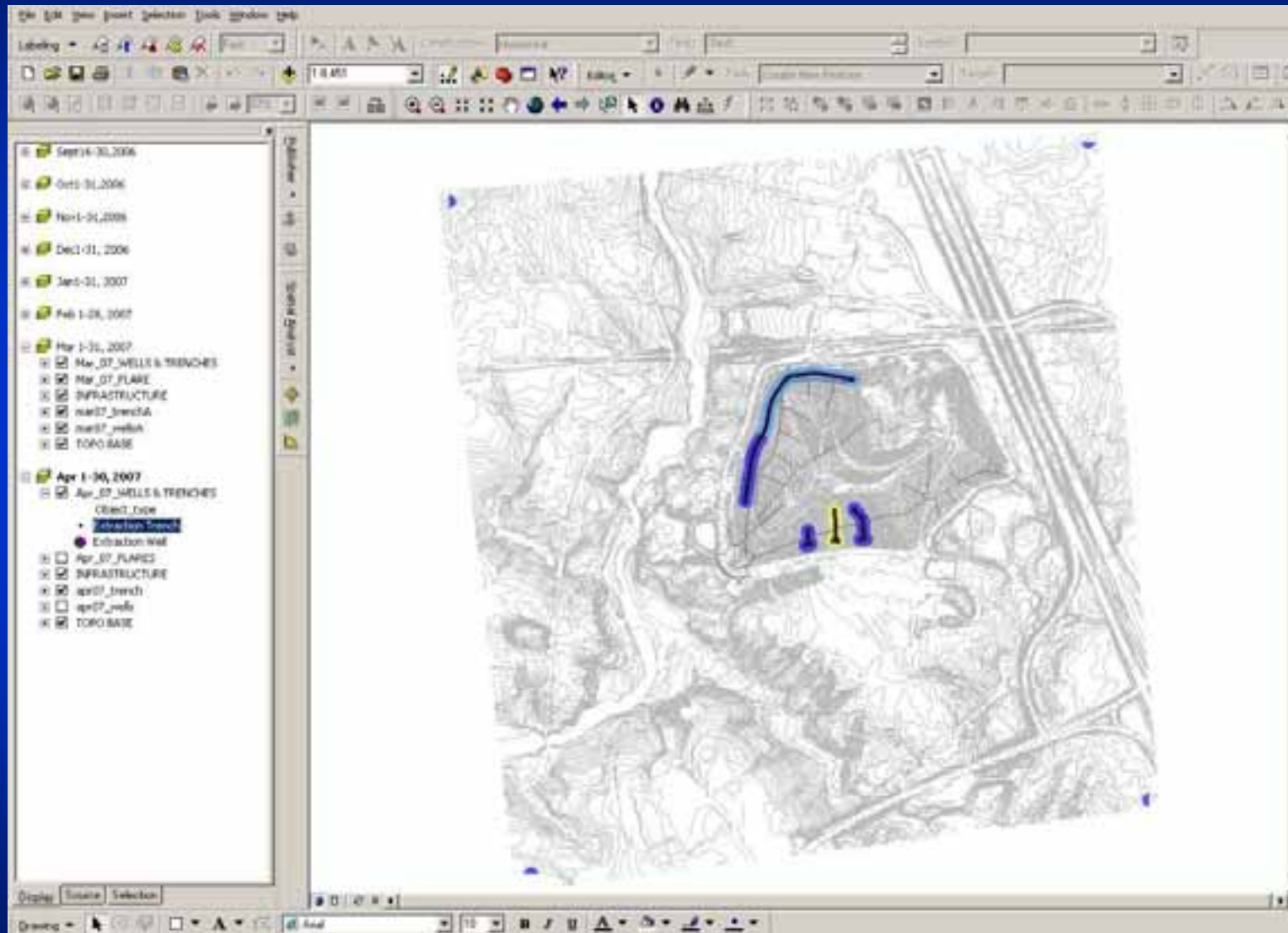
GIS METHODS



GIS METHODS (CONT.)



GIS METHODS (CONT.)



NEXT STEPS

- 3D models of landfill gas extraction systems
- Interactive, web-based applications for our clients

ACKNOWLEDGEMENTS

- Dan Schweitzer and Isabel Mamede
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- Jim Chabot
- Allison Goodwin
- Kate Emma Adams

QUESTIONS ?

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