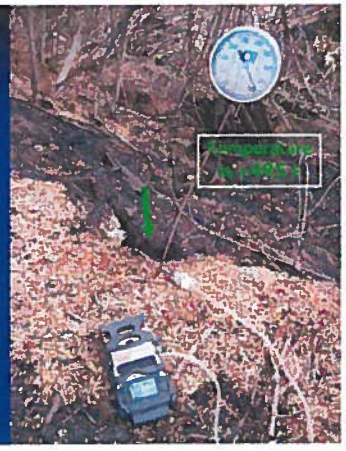
Settlement

Smoke vs. Steam

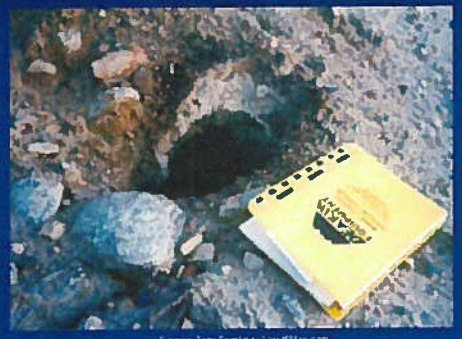
- Color difference:
  - Smoke » bluish-grey
  - Steam » white-grey
- Time/Temperature of Observation
- Transparency and Smoke Dissipation
- Easily distinguished by a field CO monitor
  - Note: Method is for Ambient Air

Venting without smoke

Temperature is your evidence



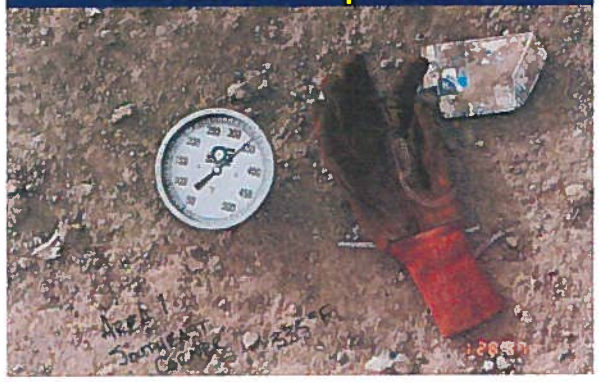
Combustion Residue



Protocols

1. Field Data
   - Temperature surveys
   - Gas sampling surveys
   - Infrared surveys
2. Data Evaluation
   - Tend Analysis

Elevated Temperature



Gas Sampling Protocol

- Primarily Carbon Monoxide
  - Detection level below 10 ppm
  - Notify lab high CH_4
- Fixed Gasses - O_2, N_2, CH_4, CO_2
- Toxic Gasses – TO-14 and/or TO-15

CO Monitoring

- Field instrumentation
  - Qualitative abilities and susceptible to cross-sensitivity with high T, H2S, and humidity
  - Must use a pre-filter
  - **Poor Results**
- Use Lab methods to determine CO
  - ASTM-D1946 (Low Detection Limit -10 ppmv)

Field Sampling

Data Evaluation

- The Landfill should have established base lines for LFG
  - Typically a landfill collects CH_4, CO_2, O_2, Temperatures, and balance gasses (N_2)
  - Freq varies but the data is available to plot over time
  - Look for trends in the wells and well fields

Data Trends for UF

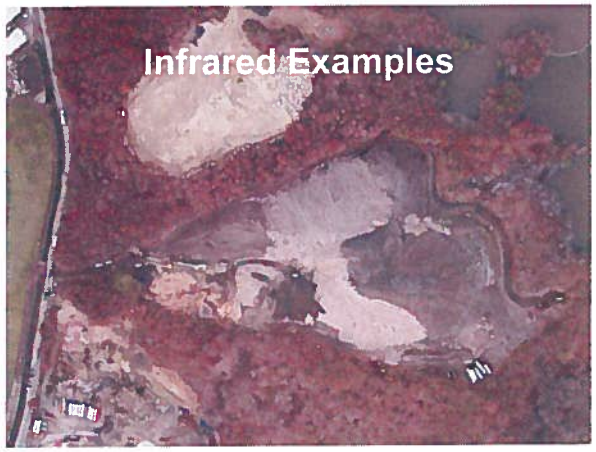
Past investigations have shown

1. Excess Oxygen or Nitrogen
2. A gradual increase in Δtemperatures
3. Spike in Δt
4. Decrease in CH_4
5. Increase in CO

Not typically sampled but you would also see an increase in Benzene, MEK, and D/F

Infrared Technology

- Does this work?
  - Yes, but depends on resolution and op
- Provides an excellent base map
- Limitations
  - Facility may be at 110 to 130 F
  - Soil cover may interfere
  - Look for large Temp Δ



Other Indicators

- Infrared
- Elevated VOCs (2 to 3 Orders of Magnitude)
  - Benzene
  - MKE (2-Butanone)
- Elevated Dioxins / Furans
  - Costly Sampling
- Leachate Composition
  - Increases in constituents
- Changes in Groundwater Data
  - Damaged liner via heat or settlement

Source: Todd Thalhamer

Confirming a Subsurface Fire

- Rapid Settlement
- Temp above 170 F
- Levels of CO above 1000 ppm w/lab analysis
  - CO between 100 & 1000 ppm are viewed as suspicious
  - CO between 10 & 100 ppm, no active fire
- Infrared will not confirm a FIRE

Health and Safety For Investigations

- H & Safety Plan
- Entering facility with explosive gas
- Use four gas meter w/CO
- UEL and LEL are present
- Intrinsically safe equipment
- Collapse Potential
- Confined Space

Health and Safety Concerns

- Past sampling of fires have shown:
  - Temperatures in excess of 500 F
  - CO levels above 28,000 ppmv
  - H2S levels at 3,000 and 25,000 ppmv
- Unsafe areas, possible collapse, due to the void spaces created by the fire.

Sink Holes

- 16 year old – three degree burns 30%
- Fell into 15 deep hole X-mas eve
- Equipment damage $$$

Youth slips into burning Bend sinkhole

Prevention

- Look for gravel pathways i.e. access roads
- Ensure soil compaction on slope
- Additional Cover > 1ft (low permeability soil)
  - Occurrence of UF, consider final cover
- Decrease extraction rate or shut down
- Increase monitoring frequency
- Prevent air intrusion through maintenance and well seals

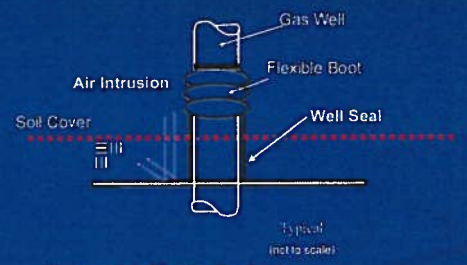
GCS Prevention

- Reduce oxygen to less than 1% for and interior well
- Reduce nitrogen to less than 10% for an interior well
- Reduce gas well temps below 135 F

Prevention – Additional Soil

- Min Perm of $1x10^{-6}$
- Max particle size 3 inches
- Classified SC, ML, CL, CH
- Extend cover min 10 ft
- Min cover 24 inches
- Max lift 9 inches

Well-Bore Seal



May consist of bentonite clay or geosynthetic membrane

Questions

- Underground Landfill Fires
- Investigation Techniques
- Sampling Criteria
- Data Evaluation
- Prevention

FOR MORE INFO...

Todd Thalhamer, todd.thalhamer@calrecycle.ca.gov

15th Annual OSC Readiness Training Program

Suppression

Paul Ruesch, EPA Region 5
Michelle Rogow, Region 9
Dan Shane, Region 9
Todd Thalhamer, State of California

Version
OSC 2012

Suppression Overview

- Resources Available
- Methods to Extinguish
- Environmental Suppression
- Health and Safety
- Heavy Equipment Operations

What Type of Fire Services is Available

- Paid
- Combo
- Volunteer
- Contract

Suppression Tactics

Based on your Pre-Fire Plan

1. Cover
2. Excavate and Foam
3. Overhaul
4. Inject inert gas (i.e., CO_2) or water
5. Flood (AKA Surround and Drown)
6. Let-it-burn
7. Accelerate (Yes It has been done!)

One Question for Suppression

Do you have a dedicated soil stockpile?

SF Landfill - Excavate

Best Approach

- Works well on subsurface fires from 1 to 30 feet
- Use hand held infrared to delineate fire material
- Use on localized problems
- Use foam with water
- Excavate material to a suppression deck
- Add additional cover 3x the surface area
- Can excavate down to 70 feet, limited

Overhaul

- Costly and Timely
- Must account for suppression water
- Need sq ft for a suppression deck
- High probability of success for a large scale incident

Overhaul – Fresno Debris

Inert Gas Injection

- Limited Results – Use on small zones
- CO_2 vs. N_2 – Recommend CO_2
- Recommend for
  - Combination of specified cover and injection
  - Pre-excavation
  - 1 to 3 GCS Wells

Inert Gas Injection

- Note of caution
  - Causes frost upheaval
  - Extreme Temps
  - Use Qualified Contractors

Water Injection

- Limited Results – Use on small zones
- Best for facilities with liners and LCS

Weight of Water?

Typical FF

Say 50,000 gal

Flooding

- In general, not recommended

[Note: 7,000 gallons a load]

- Possible stability & Leachate issues
- If used, the area should be flat and have a liner and LCS or have other mitigating circumstances

Let it Burn

- Typically selected when there is a lack of funding for suppression
- Long term air quality issues
- Stability and security issues
- Least favorable by the community

Top 3 Issues

1. Water Supply and Equipment
2. Command and Communications
3. Health and Safety

Water and Equipment

Use of Water at a LF Fire

- Pre-cool and particulate mgmt
- Knock down and equipment safety
- Surround and Drown – Not preferred
  - Last resort
- Will increase bio decomposition
- May overwhelm the LCS

Operational H&S

Your Health and Safety Plan

- Should account for all the potential exposures and site hazards
- Communications
- Hospital Locations
- Emergency Numbers
- Air Sampling Procedures
- Respiratory Issues
- Work Zone (Cold, Warm, Hot)

Respiratory Equipment

Warm Zone Firefight with Real-Time Air Monitoring

Real Time Air Data

- Photo Ionization Detector (PID)
- Particulate
- VOC.CO,H_2S, CH_4, other gasses

Respirator

- Air-Purifying Respirators
- Will Protect from particulates, dioxins, acid gasses with limits, metals
- Will not protect from CO, H_2S or Low O_2

Respirator

Source: Tony Sperling
www.firefighting.com

Use of Personal Gas Monitor

- Technique developed in the field to reduce exposures to hazardous gasses/chemical from waste fires
- Uses CO as a indicator of other byproducts of combustion
- Allows work to be conducted in the warm zone without respirators, SCBAs or supplied air

Personal Gas Meters

- Gasses to monitor based on site conditions
- The meter shall be intrinsically safe
- Look for water resistant models;
- Should clip or attach at breathing zone;
- Verify regulatory alert/alarm levels (e.g., STEL)
- Decide on disposable vs. calibrate type

Heavy Equipment Operations

- PPE
- Communications
- Blind Zones
- Kill Zones
- Escape Routes
- Supplied Air
- Min. of 2 piece of Heavy Iron

PPE at a Waste Fire

- Everyone in the hot and warm zone should be out fitted with the appropriate fire ground personal protective equipment (Bunker/Nomex®)
- This includes operators of equipment

Equipment Operators

Equipment Operators

Heavy Equipment

- Communications with FF
- Post a look but at a distance

Heavy Equipment Issue

Visibility

Equipment Zone and Rescue

Blind and Kill Zones

How do you perform a rescue from an excavator?

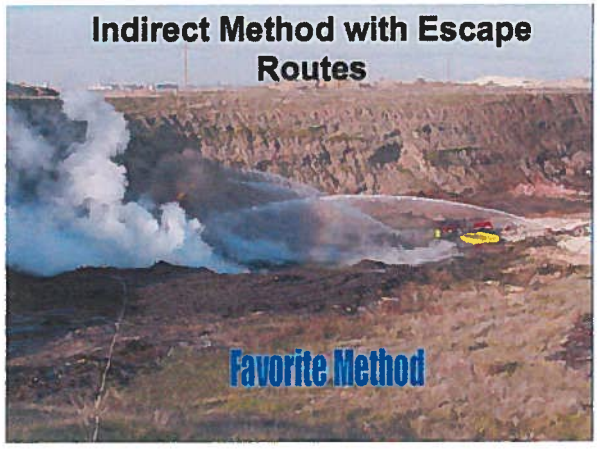
Clothing and Rescue

For Example

Tracy Suppression –Supplied Air

- $411,000/5 days
- No contaminated water was generated
- 770,000 gal of water / 990 gal of foam
- $18 Million (US) to Remove

Supplied Air and Escape Packs



Indirect Method with Escape Routes

Favorite Method

Equipment Safety

- Minimum of two pieces of equipment
  - Rescue potential, you NEED at least two
- Preferred enclosed cabs
  - Pro: Operators are more protected
  - Con: Operators are more aggressive

Bottom Line Landfill Fire Safety

- Wear appropriate respiratory protection as directed by an industrial hygienist
- Breathing air via a SCBA or supplied air should be used if you are in an area of smoke and/or H_2S. CO
- Wear fire ground PPE
- Exposure to visible smoke SHOULD BE AVOIDED without respiratory protection
- Portable CO monitors can be used to delineate the hot zone from warm

LF Suppression Summary

- Pre Plan / Health and Safety Plan
- Use available resources
- Manage your water
- Monitor personnel and work zones ► AVOID SMOKE
- Have a stock pile of soil available at all times for WMU

15th Annual OSC Readiness Training Program

Communications

Paul Ruesch, EPA Region 5
Michelle Rogow, Region 9
Dan Shane, Region 9
Todd Thalhamer, State of California

Are Waste Fires Common…

- Yes, However
- Part of the waste business
- Most are operational fires (15 min to 1 hr)
- Majority are surface fires
  - The fire commonly occur in Transfer Stations, compost facilities, and at working faces of LF
- 80-90% waste fires at LF are not reported
- Approximately one major tire fire per year

Statistics

- 1,754 landfills in U.S. as of 2006
- ~8,400 dump or sanitary landfill fires reported in U.S. each year according to National Fire Incident Records
- 1 in 200 fires escalates to a major incident
  - 42 major incidents per year?
- Probability of small fire better than 50%
- Probability of major fire estimated at 0.5%

Source: US EPA, Tony Sperling
www.landfillfire.com

How Many?

- Data is limited throughout US
- Google™ Alert
  - Used Landfill, Underground, Compost, Debris, Subsurface, and Tire Fires
  - 291 events since January 3, 2007
  - 145 events per year?
  - Found significant events even in California that were not reported

Concerned?

- Health and safety issues (FF and OP)
- Public/Community safety
- Production of unsafe levels of carbon monoxide and toxic gasses
- Dangerous subsurface conditions (e.g., voids and elevated temperatures)
- Damage to environmental control systems
- Suppression Costs
  - Delta Shake $4.0M, Westley $3.5M, Fresno $1.7M

Why significant fires?

- Lack of Pre-Plans
- Lack of Training
- Lack of Resources
- Command and Control Issues
- Illegal Storage or Dumping

Fire Problems with Landfills

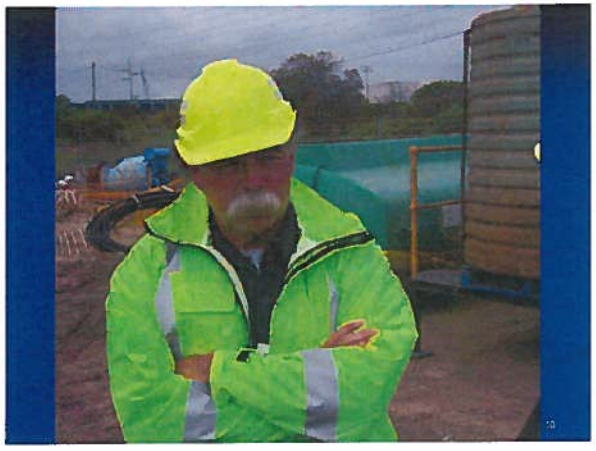
- Typical Transfer Station and/or LF
  - No Pre-Plan – Call 911 does not count
  - Lack of equip. (CO monitors)
  - Operators not fit tested
  - No communications with FD

Fire Problems at Landfills

- Typical Fire Department
  - Little knowledge on LF operations
  - Site knowledge limited
  - Lack of equip. (CO monitors)
  - No heavy equipment
  - No communications with the LF
  - Pre plans are limited

Fire Issues Regulatory Agencies

- Typical local health, environment, and State
  - Little knowledge of what it takes to suppress a fire
  - No communication
  - Responding as a regulator not as a responder



Beyond Operational Fires

- Who is in charge?
  - Classic Issue
- Fire Department Right?
- Not always
- Does the Fire Department want the liability?

Private Property

- What authority do you have?
  - Not a crime scene
  - No threat to surrounding property
  - Fire is being handled by the industry
- Number of fires in California where the Fire Department has been denied access

Liability

- Northern CA Fire Department was billed for the contaminated water they generated during the suppression ($300,000)
- Southern CA Department lost $610,000 in suppression costs due to enforcement issues

Landfill Fire Issues

- You have a mix of LF operators and FF that rarely training or know what issues exist during a major event
- You are using heavy equipment and fire resources together w/o proper communication or PPE
- You may not know the hazards present (e.g. Leachate sumps, GCS)

The Fix

- Pre Plan
- Train
- Request Resources
- Establish UC when appropriate

You have a significant fire

- Define significant
  - black cloud, additional resources needed, damage to envir. control systems, press inquiries
- Notification per your pre-plan
  - Levels
    - a. Local fire and health
    - b. Local fire, hazmat and police, health, State
    - c. Local fire, hazmat and police, health, State, US EPA, community groups, etc.

Pre Plan

- Must Consider
  - Location of Facility
  - Location of Population
  - Available H2O and Foam
  - Available Resources (HE)
  - Available Agencies
  - Environmental Impacts
  - Air Emissions
  - Funding
  - Evacuation (Red Cross)

Available Resources

- Fire Department
- Other Landfills
- Local and State Health Department
- State EPA
- US EPA
- Private FF companies
- Private Consultants

Resource List

- Per you Pre Plan!
  - Contacts numbers, emergency notifications, fire, environmental agencies, press, etc.

Communications

- Paramount to an incident
  - Establish on-site and off-site communications
  - Critical to employee safety and the welfare of the community
  - Success is dependent on communications

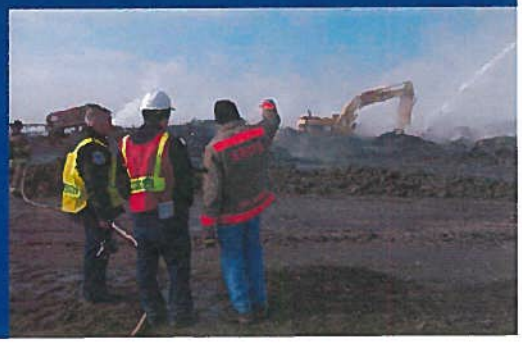
On-site Communication

- Need to establish communications among resources
- Can FF communicate with heavy equipment?

On-site Communication

- Objectives and goal should be communicated thru incident command
- At a min, conduct a safety meeting before work
- Large scale incident – two meeting, morning safety and afternoon debriefing
- All supervisors and team leaders should attend

How to Communicate the Plan?



Incident Action Plan

Video

IAP

- Incident Action Plan
  - Incident Command System Forms
    - http://training.fema.gov/EMWeb/IS/ICSResource/ICSResCntr_Forms.htm
- Excellent format for incident briefing, incident objectives, organizational assignments, radio communications plan, medical plan, organization chart, safety plan, etc
- Can range from simple to complex

IAP Examples

- GOH – Fresno Debris Fire
- Last Rubble Pile – SF Landfill Fire

Off-Site Communication

WHY?

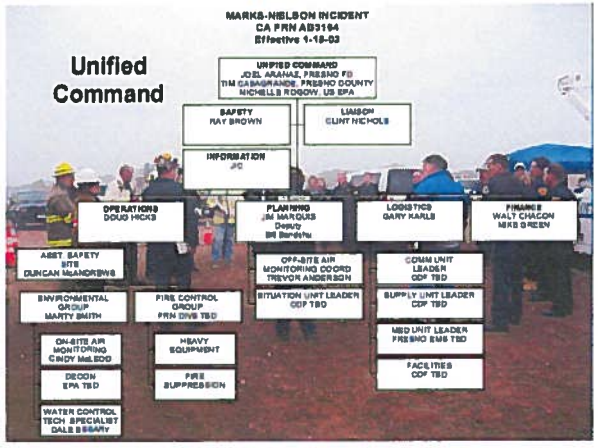
- You need the Press, they are your link to the community.

Off-Site Communication

- Manage the Public Relations
  - The Press will FIND a story
  - Better to work with then against
- Establish an Incident Command Post
  - Needs to be located a safe distance from the incident and UPWIND. Be prepared to move!
  - Press will go to the ICP

Managing PR

- All communication go thru the PIO
  - All questions/issues get forwarded to the PIO
  - Work with the local media
  - Issue press releases. Be Honest!
- Provide Security
  - Control Site Access
    - If not, the Press and Public will just show UP!
- Establish Joint Information Center on large fires
  - All agencies, contractors, landfill reps speak with one voice thru the JIC



PR Management

Video

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Environment

Paul Ruesch, EPA Region 5
Michelle Rogow, Region 9
Dan Shane, Region 9
Todd Thalhamer, State of California

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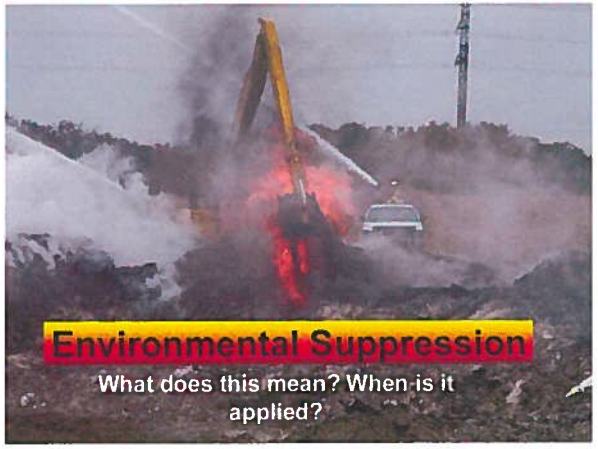


Environmental Suppression

- Definition
  - Knowing your suppression tactics will have an impact on the ecosystem (physical and biological components) and taking action to minimize these impacts

Suppression Impacts

- Magnitude of impacts will vary depending on location facility and surrounding land use
- Must account for impacts to soil, water, air, and sociological factors
- Your Decisions may increase damage to the environment
- Your Lack of Decision may increase damage to the environment

Foams

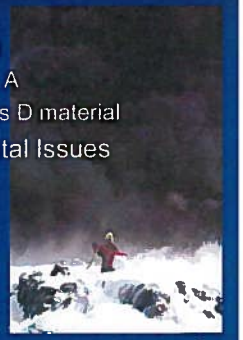
- Water has limitations in cooling and penetrating class A fuels (e.g., wood, paper) because of a naturally high surface tension.
- This high surface tension causes water to form into droplets
- Class A foam reduces surface tension and allows more water to penetrate.
- One key is that foams aiding in the prevention of rekindles.

Special Sauces

- Class A - Ordinary combustible
- Class B – Flammable Liquid and gas
- Class C – Electrical
- Class D – Metal Fires
- Class K – Cooking oils

Which Foam to Use?

- Select the Class of Foam
  - Most LF Fire will be Class A
  - Some may work with Class D material
- Examine the Environmental Issues
- Determine the supply
- Do not mix foams
  - Unknown compatibility
- Find the MSDS



Foam Safety USDA

- Standard Test Procedures,
- Section 1—Health, Safety, and the Environment
  - STP 1.1—Review of Disclosure Information
  - STP 1.2—Risk Assessment
  - STP 1.3—Mammalian Toxicity
  - STP 1.4—Biodegradability
  - STP 1.5—Fish Toxicity
  - STP 1.6—Photo-Enhanced Fish Toxicity
  - STP 1.7—Cleveland Open Cup Flash Point and Fire Point

Source: www.fs.fed.us

Continued Foam Tests

- Standard Test Procedures, Section 2—Fire Tests
- Standard Test Procedures, Section 3—Determination of Optimum Mixing Test
- Standard Test Procedures, Section 4—Physical Properties
- Standard Test Procedures, Section 5—Material Effects
- Standard Test Procedures, Section 6—Product Stability Tests
- Standard Test Procedures, Section 7—Pumpability Test
- Standard Test Procedures, Section 8—Class A Foam Effectiveness Tests
- Standard Test Procedures, Section 9—Water Enhancer Effectiveness Tests
- Standard Test Procedures, Section 10—Visibility Test
- Standard Test Procedures, Section 11—Air Drop Characteristics Test
- Standard Test Procedures, Section 12—Operational Field Evaluation Test
- Standard Test Procedures, Section 13—Lot Acceptance and Quality Assurance
- Standard Test Procedures, Appendix—Sources of Referenced Documents

Source: www.fs.fed.us

Approved Foam

- Per USDA Forest Service
  - Ansul Sil-Ex
  - FireFoam 103B 3
  - Phos-Chek WD 881 4
  - FireFoam 104
  - Angus ForExpan S
  - Pyrocap B-136
  - Phos-Chek WD 881-C
  - Phos-Chek Anchor Point
  - National Foam KnockDown
  - Summit FlameOut
  - Angus Hi-Combat A 5
  - Buckeye Platinum Class A Foam
  - Chemguard First Class 6
  - Solberg Fire-Brake 3150A 7
  - Phos-Chek First Response

See
http://www.fs.fed.us/rm/fire/documents/qpl_fm1.pdf

Source: www.fs.fed.us

Foam Toxicity

- **Fish Toxicity of Class A Foam Concentrates**
  - Rainbow Trout, 60 post hatch, 96 hr exposure
  - LC_{50} ranged from 10 mg/L to 156 mg/L for approved foams
  - The lower values indicate greater toxicity
  - 10 of 15 foam were below or at 30 mg/L
    - One drop in your gas tank (13 gallons) is ~ 1 ppm

http://www.fs.fed.us/rm/fire/w/fcs/performance/documents/fish_fm_sum.pdf

Damage to Environmental Controls

- Landfill Fires will melt, burn, deform, or destroy environmental LF controls
- These controls are necessary to protect the public and comply with State and Federal laws and regulations
- Without controls, the landfill will be in violation

Landfill Temperatures

- At what temperature are landfill designed to handle?
  - Answer:
- Previous Landfill Fires (Surface and Subsurface) have damaged or destroy LCS, Liner, GCS, Equipment.
- The lost of these systems have increased the risk to groundwater and off site gas migration

Maximum Temperatures

- At what temp does HDPE melt?
  - Answer: Above 140 °C (284 °F)
    - Source. Welding of HDPE Geomembranes. 2007, Werner W. Muller
- At what temp does a liner start to lose it structural properties?
  - Answer:

Melted HDPE Liner

How do you Account for Exposures and Hazards

- Health and Safety Plan
- This plan documents how you intend to reduce or eliminate exposures and hazards

Health and Safety

- Everyone's Responsibility
- We can't not teach H&S for a landfill fire in a 1 hour presentation
- Your Goal:
  - to recognize the hazards
  - Take action to protect your team
  - Make a plan
  - Hire a certified industrial hygienist with LF fire experience

Health and Safety Plans

Fresno Debris

- Site safety plan developed by CIWMB and USCG
- Audited by California OSHA
- Reviewed and signed off by all personnel
- SF Landfill Fire –Last Rubble
- Small one day fire
- Extensive Real-time Air Monitoring

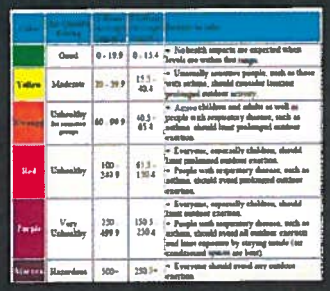
What about a Community Safety Plan

Past Results at Waste Fires

- LFCI has encountered H2S at 3,000 and 25,000 ppm at the last two DLC fire projects
- CIWMB has recorded CO at 28,000 ppm
- PM 2.5 level have been recorded at hazardous levels

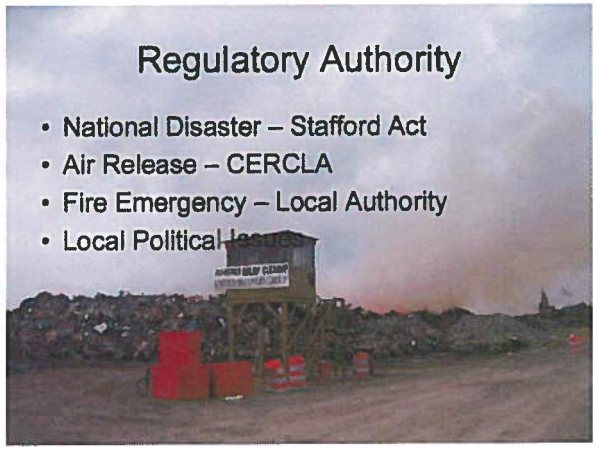
PM-2.5

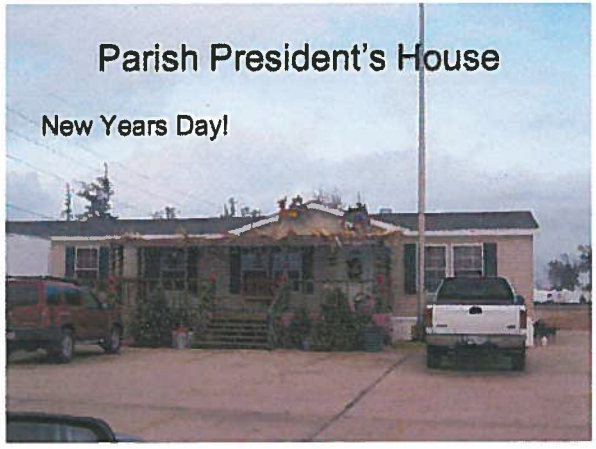
Smoldering Fires

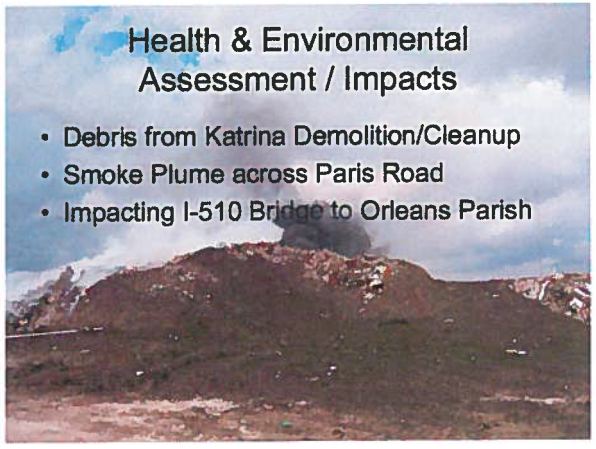


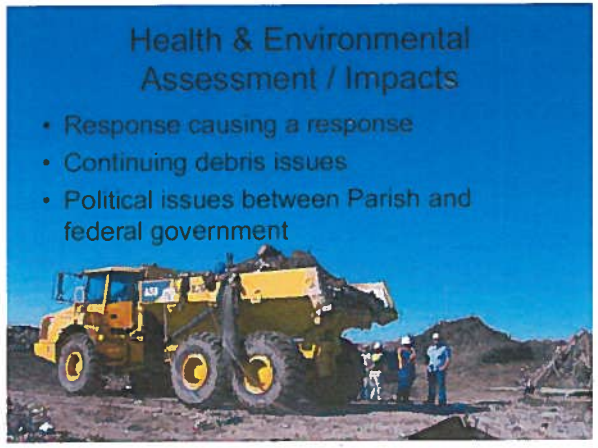
	Good	0 - 19.9	0 - 15.4	→ No health impacts are expected when levels are within this range.
Yellow	Moderate	20 - 39.9	15.5 - 40.4	→ Unusually sensitive people, such as those with asthma, should consider limiting prolonged outdoor activity.
Orange	Unhealthy for sensitive groups	40 - 99.9	40.5 - 65.4	→ Anyone children and adults as well as people with respiratory disease, such as asthma, should limit prolonged outdoor exertion.
Red	Unhealthy	100 - 349.9	65.5 - 150.4	→ Everyone, especially children, should limit prolonged outdoor exertion. → People with respiratory disease, such as asthma, should avoid prolonged outdoor exertion.
Purple	Very Unhealthy	350 - 499.9	150.5 - 250.4	→ Everyone, especially children, should limit outdoor exertion. → People with respiratory disease, such as asthma, should avoid all outdoor exertion and limit exposure by staying inside (or conditioned spaces are best).
Maroon	Hazardous	500+	250.5+	→ Everyone should avoid any outdoor exertion

Paris Road Landfill Fire
St. Bernard Parish, LA
January 1, 2006
Happy New Year!


Regulatory Authority
• National Disaster – Stafford Act
• Air Release – CERCLA
• Fire Emergency – Local Authority
• Local Political Issues


Parish President's House
New Years Day!


Health & Environmental Assessment / Impacts
• Debris from Katrina Demolition/Cleanup
• Smoke Plume across Paris Road
• Impacting I-510 Bridge to Orleans Parish


Health & Environmental Assessment / Impacts
• Response causing a response
• Continuing debris issues
• Political issues between Parish and federal government

Suppression Techniques & Tactics
• Stationary Monitors - unmanned