Elements of Proper Landfill Design, Operations and Maintenance

Brian Guzzone
Eastern Research Group, Inc.
Overview

- What is a proper disposal site?
- Transforming the dump – simple and cost effective improvements
- Working face management
- Daily cover and alternative cover
- Landfill fires
- Health and safety
- Q&A
Proper Disposal Site

- Proper disposal sites have measures/programs in place to protect human health and the environment
  - Liners
  - Covers
  - Compaction
  - Leachate management
  - Gas collection
Modern Sanitary Landfill
Development of a Landfill
Landfill During Operations
Completed Landfill
Liners help to:

- Provide containment of contaminants
- Reduce groundwater contamination
- Reduce landfill gas migration

Liners may be composed of:

- Clay
- Composite (clay and geomembrane)
Landfill Covers

- Provides protection for human health and environment
- Promotes stormwater runoff
- Reduces stormwater infiltration
- Provides protection against fire
- Improves landfill gas generation
- Improves ability to collect landfill gas
- Reduces odors
- Provides vector control
Final Cover Components

- **Constructed Soil Cover**
  - Clay or low permeable soil (60 cm)
  - Vegetative layer – soil to support vegetation (15 to 30 cm)

- **Geomembrane**
  - Can be used to further reduce infiltration
  - If used should be above clay cap
  - Should be in direct contact with clay
Final Cover Components

- **Stormwater controls**
  - Object is to promote stormwater runoff before it infiltrates and becomes leachate
  - Prevent erosion of final cover
  - Benches can be used on steep slopes
  - Rip rap and gabions can be used in high erosion areas
  - Top of landfill graded to promote runoff (i.e., dome shape)
Compaction

- Extends the life of the landfill
- Decreases settlement
- Reduces voids
- Discourages wind-blown litter
- Discourages insects and rodents
- Reduces the possibility of waste run-off
- Reduces the amount of cover needed
- Provides a more solid surface for travel
- Reduces leachate
Leachate Management

- Prevent stormwater from running onto the working face
- Improve stormwater run-off controls in areas around working face
- Reduce infiltration
  - Avoid ponding on landfill
  - Maintain vegetative cover
- Once in contact with waste – best to prevent stormwater run-off (contaminated stormwater)
Leachate Collection

- Perimeter Ditch - can be used to drain leachate and carry it to treatment system
- Subsurface Perimeter Gravity Drain - can be built around landfill
- Vertical Well Pumps – pumps are effective but expensive
Leachate Treatment

- Evaporation ponds
- Leachate evaporation using landfill gas
- Wetland treatment
Gas Collection

- Prevents gas build-up which may lead to combustion
- Passive or active systems may be used
  - Passive systems consist of collection wells (constructed of perforated piping) which are vented to the surface
  - Active systems also have collection wells but also include valves and vacuums or pumps
Transforming the Dump

Simple and cost effective improvements can transform an open dump into a proper disposal site

First,
- Ensure the site is appropriate for proper disposal site (well drained, not in proximity to groundwater reservoir, adequate space, etc.)
Transforming the Dump: Open Dumping to Controlled

- Site preparation:
  - Level and grade existing waste
  - Relocate any structures (such as storage areas for recyclables or shanties) outside the disposal area
Transforming the Dump: Open Dumping to Controlled

- Operation:
  - Establish operating hours
  - Develop disposal plan (no toxic or hazardous wastes)
  - Register, weigh and check vehicles entering site
  - Supervise unloading of waste
  - Deposit waste in thin layers
  - Compact waste
  - Cover surface daily
  - Install movable litter barrier downwind of site
  - Maintain records
Transforming the Dump: Open Dumping to Controlled

- Additionally:
  - Install gas collection and rainwater diversion
  - Maintain access roads
  - Install access walls and gates
  - Provide staff for landfill operation
  - Perform environmental monitoring (from simple visual inspections to sample collection and laboratory analysis)
Working Face Management

- Access to Working Face:
  - Access roads need to be all-weather roads.
  - Drainage is key.
Access to Working Face

- Tipping area needs to be accessible during wet weather operations.
- Keep equipment pushes to cell as short as possible.
- Have a contingency plan.
Working Face
It all starts on the tipping area!
Working Face

- Trash dumped on tipping area—pushed to open face
- Tipping area can be made of gravel, crushed asphalt, concrete, clay, or fill dirt.
Working Face

- Keep vehicles off the working face, minimizing damage and increasing unloading time
- Built to accommodate several vehicles at once and divert water away from the working face
Working Face

- Trash is pushed by a dozer to the working face—closer is better!
- Two basic types of cell construction methods—build from the top or from the bottom
Working Face
Building from the Bottom

- Push trash from the bottom of the slope and work it up the face towards the top
- Provides greater compacting effort when using a track-type equipment
Working Face Building from the Bottom

- Easier to maintain
- “Waterfalling” garbage is eliminated
- Equipment must work harder
- All garbage has to be pushed uphill
Working Face Building from the Bottom Sloping Lifts

- No need to judge the starting footprint size of the cell
- Uniform, square cornered cells are easier to build
Working Face
Building from the Top

- Garbage can be pushed downhill
- Much easier for dozers, less wear on machines
Working Face Building from the Top

- Increased potential for “waterfalling” garbage
- Less compaction when using a track type piece of equipment
Daily and Alternative Cover
Benefits of Daily Cover

- Provides protection against fire
- Reduces stormwater infiltration
- Promotes stormwater runoff
- Improves landfill gas generation (creates anaerobic conditions)
- Improves ability to collect landfill gas
- Reduces odors
- Provides vector control
- Controls access of waste scavengers & recyclers
- Controls litter
Daily Cover
Application

- Any soil material suitable for cover
- Source should be close to site
- Spread in 15 cm lifts to achieve even layers
Daily Cover Application

- Usually stripped off each morning
- Leave close to working face for reuse
- Able to reclaim air space
Alternative Daily Cover

- Other inert materials can be used for daily cover
  - Shredded tires
  - Ash and residues
  - Stormwater system residues and sediment
  - Compost
  - Shredded C&D (not wallboard)
  - Tarps
Alternative Daily Cover

**Advantages**

- Use of material that would require disposal anyway
- Save on expense of excavating soil
- Covers such as tarps save on landfill air space
Bird Control – Simple Solutions

- U.S. law: existing landfills no closer than 10,000 ft (3 km) for turbojet only…landfills have to demonstrate no bird hazard to aircraft. New landfills prohibited within 5 miles (~8 km) of a turbojet airport

So what can I do…?

- Applying daily cover
- Air/sound devices
- Visual devices
- Bird v. bird
Landfill Fires

Two types:
- Surface
- Sub-surface
Surface Fires

Causes:

- Usually result from off-site source - "Hot" loads
- Can be started by equipment
- Smoking on landfill
- Can be started by waste-pickers/scavengers
Surface Fires

“Hot” loads could include

- Brush
- Leaves
- Construction debris
- Fireplace coals
- Burn barrel residues
Surface Fires

- Observe all loads at working face
- If load is suspected to be hot
  - Spread it thin
  - Isolate load
  - Wet it down
Surface Fires

Smoking is most common cause of surface fires.

- No Smoking!
- Smoke in designated areas only
Surface Fires

Waste pickers….

- Set fires to recover metals
- Limit access to working face
- Provide separate sorting area
Sub-Surface Fires

- Result from air infiltration in landfill
- Fire is below the surface
- Difficult to extinguish
- Need to know the signs of such a fire
Sub-Surface Fires

Fuel is abundant:

- Any waste in place is fuel!
  - Municipal solid waste
  - Construction debris
  - Leaves
  - Brush
- Landfill gas
Sub-Surface Fires

Signs of a sub-surface fire include:

- Sudden subsidence and depressions
- Fissures
- Venting Holes
- Rills
Sub-Surface Fires
Sub-Surface Fires
If there is Sub-Surface Fire Burning?

- Confirm the fire-carbon monoxide testing, temperatures, etc
- Identify the source of oxygen
- Cut off the oxygen supply
- Reseal the cover in the affected area
- Monitor the area
Sub-Surface Fires

Prevention:
- Limit all air/oxygen intrusion
- Monitor site conditions regularly
- Maintain all cover on closed portions of site
- Balance LFG system
- Check well temperatures and oxygen readings regularly
Health & Safety Basics

- Standard Operating Procedures
- Site safety plan
- Equipment training
- Personnel protective equipment (PPE)
- Chemical & natural hazards
- Confined spaces
- Hazardous waste
Standard Operating Procedures

- Established safe work practices
- Team Understands Safety
- “How-to” Manual on how to perform tasks
Site Safety Plans

- Resource for Health & Safety Topics
- Should include:
  - What to do in an emergency
  - Location of the closest hospital
  - Potential site hazards
  - Required personal protective equipment (PPE) for tasks
  - Emergency procedures
Equipment Training

- Personnel should be properly trained
- Use equipment for its intended purpose
Equipment Training

- Maintain equipment
  - Safety pre-checks
- Use caution when operating
- Examine your work area and look for hazards before working
Personal Protective Equipment (PPE)

Should include:

- Hard hat
- Steel toe boots
- Safety vest
- Gloves
- Ear protection
- Eye protection
Personal Protective Equipment

- Job required PPE
- Choose the proper gear for your job
- Know the limits of each piece of PPE
Personal Protective Equipment

- Safety Vests - Used for visibility
- Hearing protection - loud working environments
- Hard hats - falling objects
- Glasses to protect eyes
Chemical Hazards

- Chemical Hazards include:
  - Gasoline
  - Acid
  - Batteries
  - Oil
  - Chemicals
  - Pesticides

- Use caution
- Limit exposure to material
- If it must be handled, use PPE
Natural Hazards

- Natural Hazards Include:
  - Insects
  - Arachnids
  - Snakes
  - Mammals
  - Poisonous plants

- Be aware
- Learn to recognize the hazards
Confined Spaces

- Limited means of entrance and exit
- Can be bodily entered
- Not designed for continuous occupancy
Confined Spaces

- Manholes
- Chemical storage bins
- Trenches
- Utility closets
- Railcars
- Pump Stations
Confined Spaces

- Potential Dangers:
  - Engulfment
  - Oxygen deficiency
  - Oxygen enrichment
  - Flammable gases
  - Combustible dusts
  - Toxic substances
  - Physical hazards
Confined Spaces

- If entry is required, special training is needed
- Requires three person team with specialized safety equipment
Bloodborne Pathogens

- **Exposure:**
  - Medical waste
  - Needle sticks (most common)
  - Cuts from other contaminated sharps (scalpels, broken glass, etc.)
  - Contact with the eye, nose, mouth or broken skin with contaminated blood or body fluids

- **Types:**
  - Hepatitis B virus (HBV), and the hepatitis C virus (HCV)
  - HIV – the virus that causes AIDS
Bio-hazards

- Diapers
- Animal carcasses
- Rotten wood
- Sludge
- Wear gloves, wash hands before eating, drinking or smoking
- Clean, disinfect and bandage cuts
Questions?