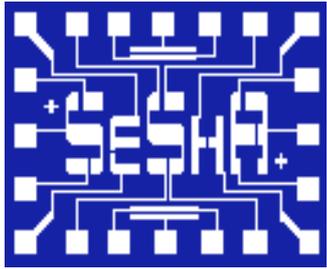




Waste Minimization: Is It Cost Effective During Decommissioning and Decontamination?



***SESHA/DTSC Joint Pollution
Prevention Mini-Conference
November 5, 2003***

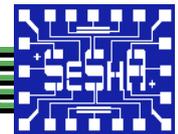


***Presented by:
Bill Belk
DECON Environmental Services, Inc.***



Questions Often Asked

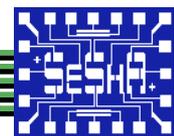
- 1) ***“Is there really a need to minimize waste during decommissioning?”***
- 2) ***“How do I define the decommissioning process?”***
- 3) ***What specific process steps do I need to address to get financial savings using waste minimization?***
- 4) ***How clean does clean need to be?***
- 5) ***“What is an example of applying waste minimization and how much was actually saved?”***
- 6) ***“Are all the waste streams we examine always cost effective to minimize?”***





Quick Answers

- 1) Yes, there is a need – environmental, cost of ownership, good business**
- 2) Look at the definition of the site facility, systems and sub-systems**
- 3) In four major process flow steps – many tasks and decisions to make in order to identify and capture savings**
- 4) In simple terms...define the assets final disposition and verification sampling protocol needed**
- 5) Fab closure example to follow**
- 6) No, in some cases the total cost does not warrant applying waste minimization efforts**





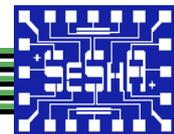
Disposition Options

□ **Facility**

1. Convert & upgrade
2. Decommission & mothball
3. Sell “as is”
4. Upgrade & clean for another use
5. Decommission & demolish for sale and redevelopment

□ **Tool/Equipment**

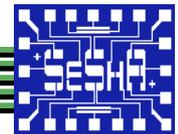
1. Sale and transfer for reuse (“as-is”, refurbish, or upgrade)
2. Storage for future use
3. Scrap or salvage
4. Donation
5. Disposal





Fab Closure Example - Background

- ❑ **40,000 sq. ft. semiconductor fab**
- ❑ **15 years old**
- ❑ **Environmental closure
cost ~ \$1 Million**
- ❑ **Closure conducted in California
under strict regulatory oversight**

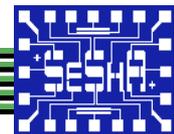




Fab Closure Cost Table

□ Key to Acronyms and Definitions

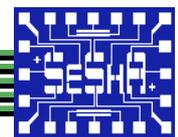
- **FRP** – Fiber Reinforced Polymer – various composition of fiberglass
- **S/S** – Stainless Steel
- **GALV** – Galvanized or Carbon steel
- **Plastic** – PVC, Polypropylene, ABS, Polyethylene
- **L** – Landfill disposal
- **NH** – Non-hazardous waste by Federal, State, and Local Jurisdictions
- **H** – Hazardous waste (RCRA, Non-RCRA, State-mandated, Client-mandated)
- **R** – Recycled
- **OF** – Offsite Facility not owned by company
- **ON** – Onsite or internal reuse at the same or another company owned facility
- **Auxiliary Tool Process Equipment** – vacuum pumps, abatement equipment, control equipment, etc





Fab Closure Cost Table

- ❑ **Cost Without Waste Minimization includes:**
 - Disposition as hazardous waste in a landfill or treatment facility
- ❑ **Cost With Waste Minimization includes:**
 - Recover waste to valuable asset applying effective cleaning techniques and defensible verification sampling & analysis protocol to show waste does not contain residual chemicals at unacceptable levels (as defined by Federal, State, Local regulations, DOT, and/or client-mandated requirements)
 - Reducing the volume of waste by onsite compression, treatment, and/or filtration methods

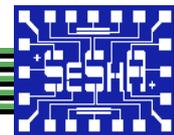
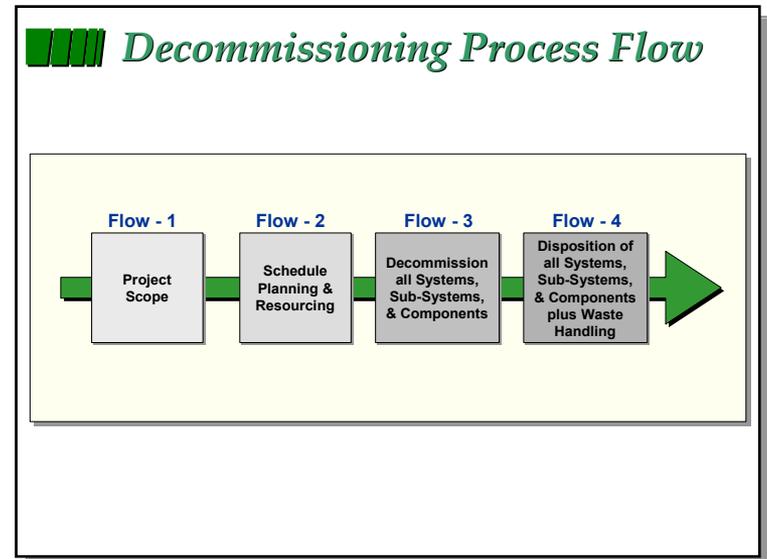
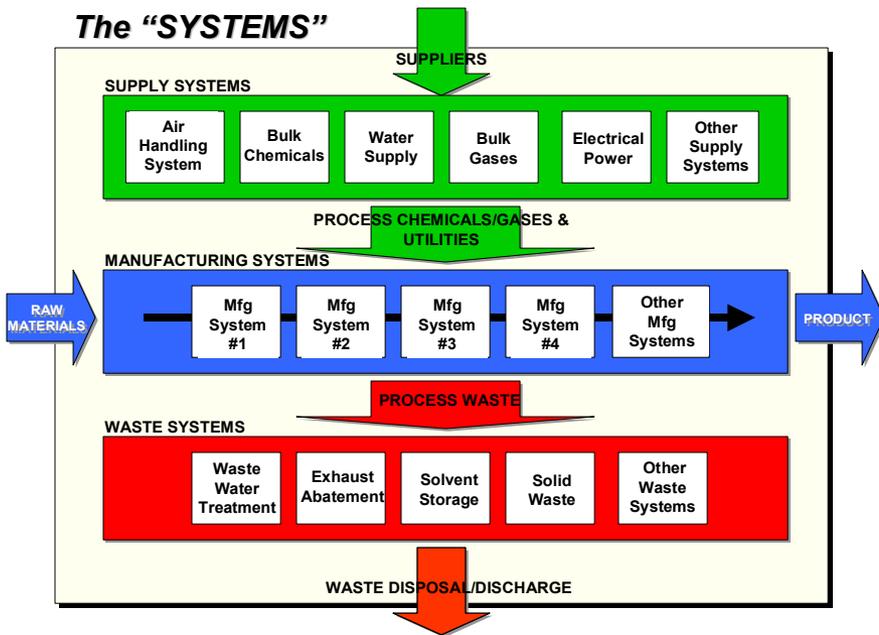


Type of Waste	Construction Material	Disposition Options	Cost Without Waste Minimization (\$)	Cost With Waste Minimization (\$)
Acid Exhaust Duct	FRP	L-H, L-NH	25,000	4,000
Acid Exhaust Duct	S/S	R-OF	25,000	2,500
Solvent Exhaust Duct	S/S or GALV	L-H, R-OF	10,000	15,500
Acid Supply & Waste Piping	Plastic	L-NH, R-OF	5,000	500
Acid Supply & Waste Piping (HF)	S/S	L-NH, R-OF	6,000	1,200
Solvent Supply & Waste Piping	GALV	L-NH, R-OF	5,000	1,500
Gas Piping	S/S	R-OF	5,000	500
Gas Cabinets	GALV	R-ON	12,000	1,500
Tool Exhaust Pipe	S/S	R-OF	10,000	1,500
Tool Process Pipe	Plastic	L-H	10,000	2,000
Auxiliary Tool Process Equipment	S/S, GALV, Plastic	L-NH, R-ON, R-OF	35,000	5,000
Acid Waste Neutralization Tanks	Plastic	L-NH	4,000	1,200
HF Waste Treatment Tanks	Plastic	L-NH	5,200	2,500
Wastewater Corrosive Chemical Supply Tanks	Plastic, GALV	L-NH, R-OF	5,800	1,500
Solvent Waste Tanks	GALV, S/S	R-OF	4,300	1,000
Solvent Supply Tanks	S/S	R-OF	4,700	500
VOC Abatement System	GALV, S/S	R-ON	4,700	0
Acid Fume Scrubbers (6)	FRP	R-OF	7,300	0
Acid Fume Scrubber Packing	Plastic	L-H	4,000	7,000
<i>Table 1 - Fab Closure Example for Waste Minimization</i>		Total Waste Min. Cost	\$188,000	\$49,400
		Total Savings	\$138,600	



Decommissioning Process

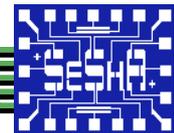
- ❑ Site definitions and systems
- ❑ Decommissioning Process Flow





Some Definitions – Many Versions

- ❑ **Decommissioning:** *The process of safely bringing down and disassociating a system, sub-system, or component*
- ❑ **System:** *An assemblage or combination of things or parts forming a complex or unitary whole to accomplish a specific process*
- ❑ **Sub-system:** *A secondary or subservient system; part of a system*
- ❑ **Component:** *An individual element in something larger (e.g. a sub-system or system)*
- ❑ **Item:** *A system, sub-system, or component*
- ❑ **End-State:** *The final appearance of the facility including the extent of decontamination required*
- ❑ **Disposition:** *What the end-state will be for systems, sub-systems, and components (e.g. move to another facility, store, salvage, waste, etc.)*

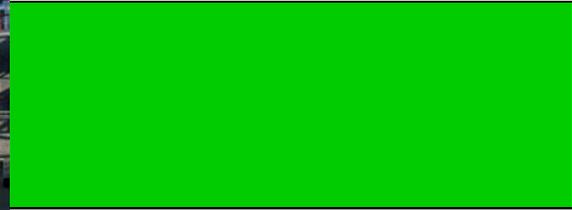
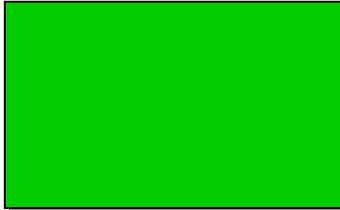


The "Site"



The “Components of the Site Facility”

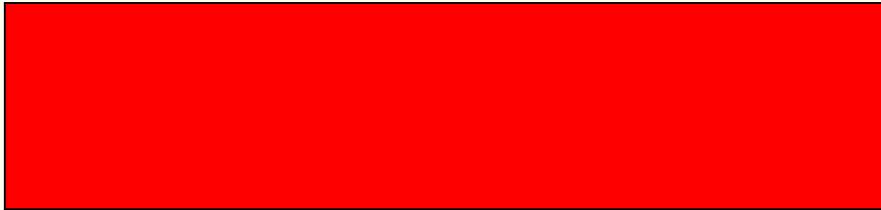
SUPPLY FACILITIES



MANUFACTURING FACILITIES



WASTE FACILITIES



The "SYSTEMS"

SUPPLIERS

SUPPLY SYSTEMS

Air
Handling
System

Bulk
Chemicals

Water
Supply

Bulk
Gases

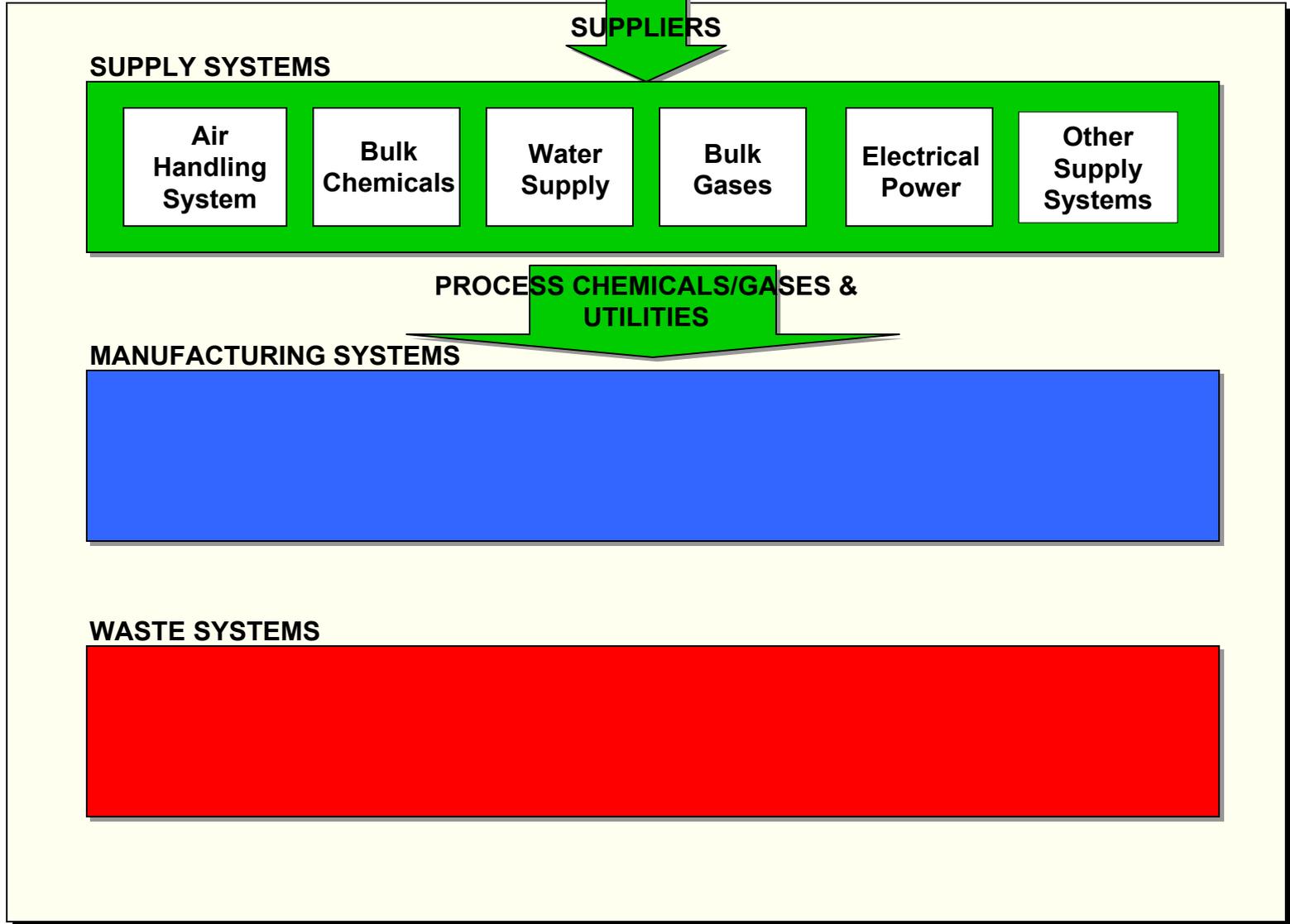
Electrical
Power

Other
Supply
Systems

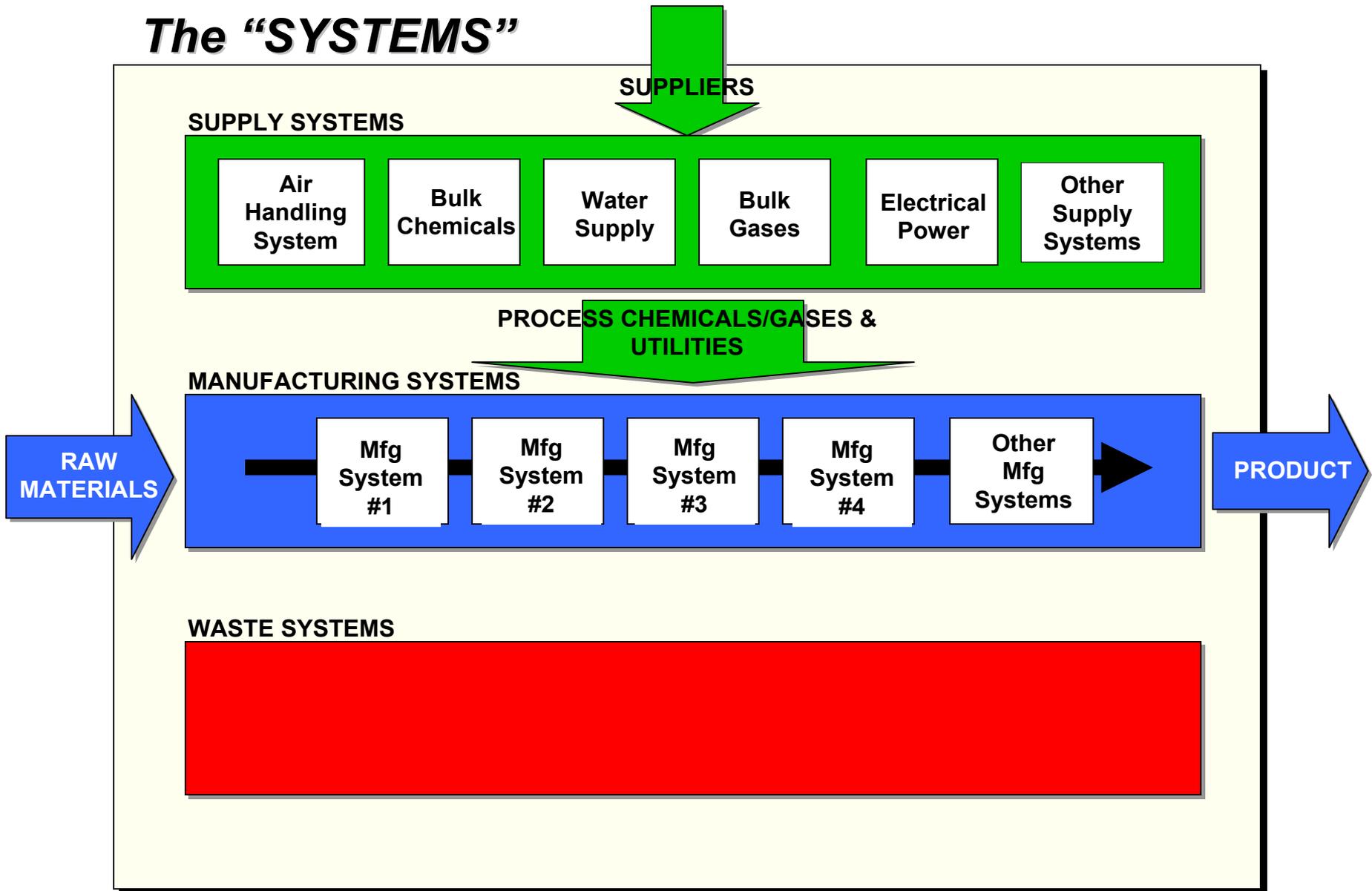
PROCESS CHEMICALS/GASES &
UTILITIES

MANUFACTURING SYSTEMS

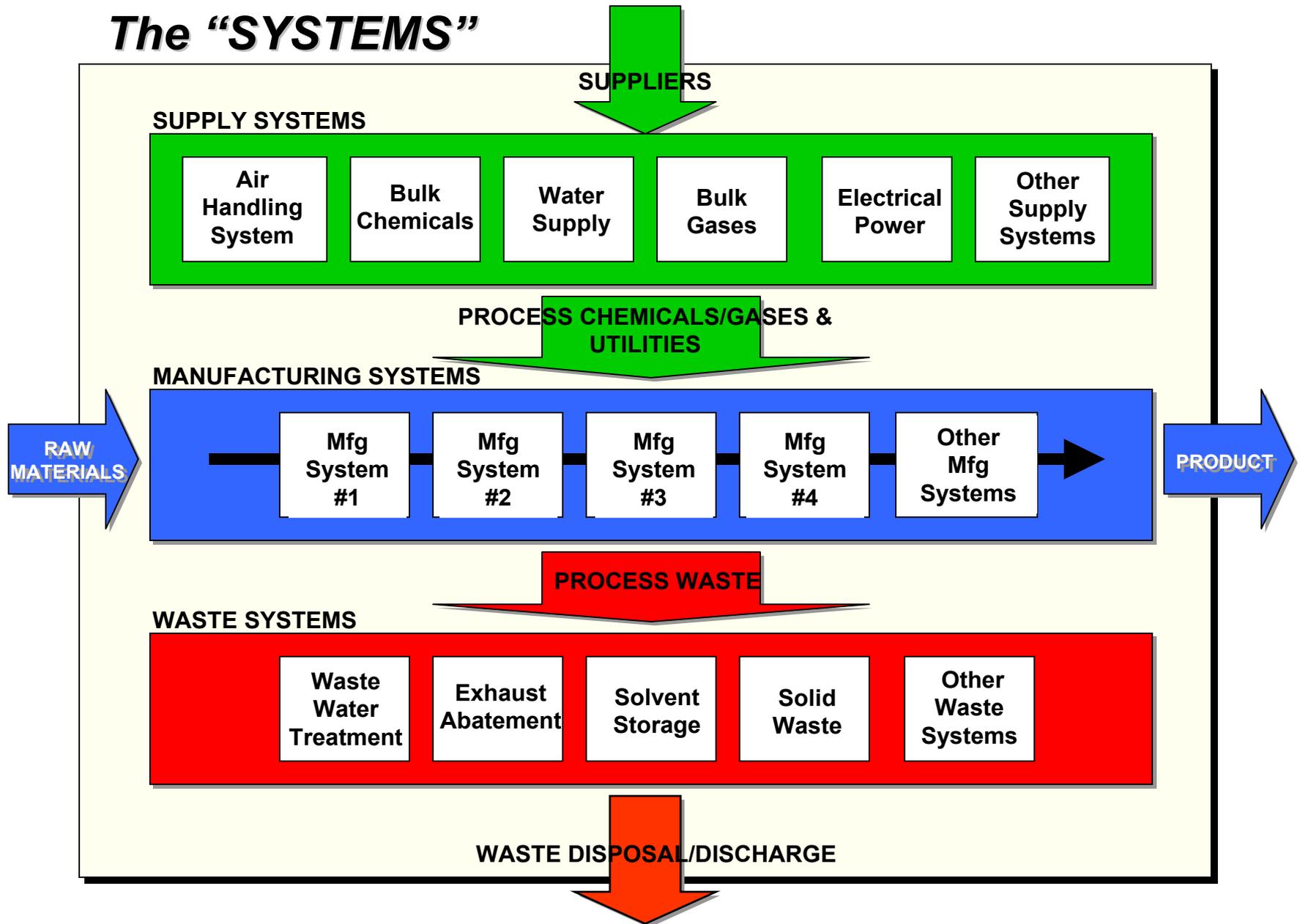
WASTE SYSTEMS



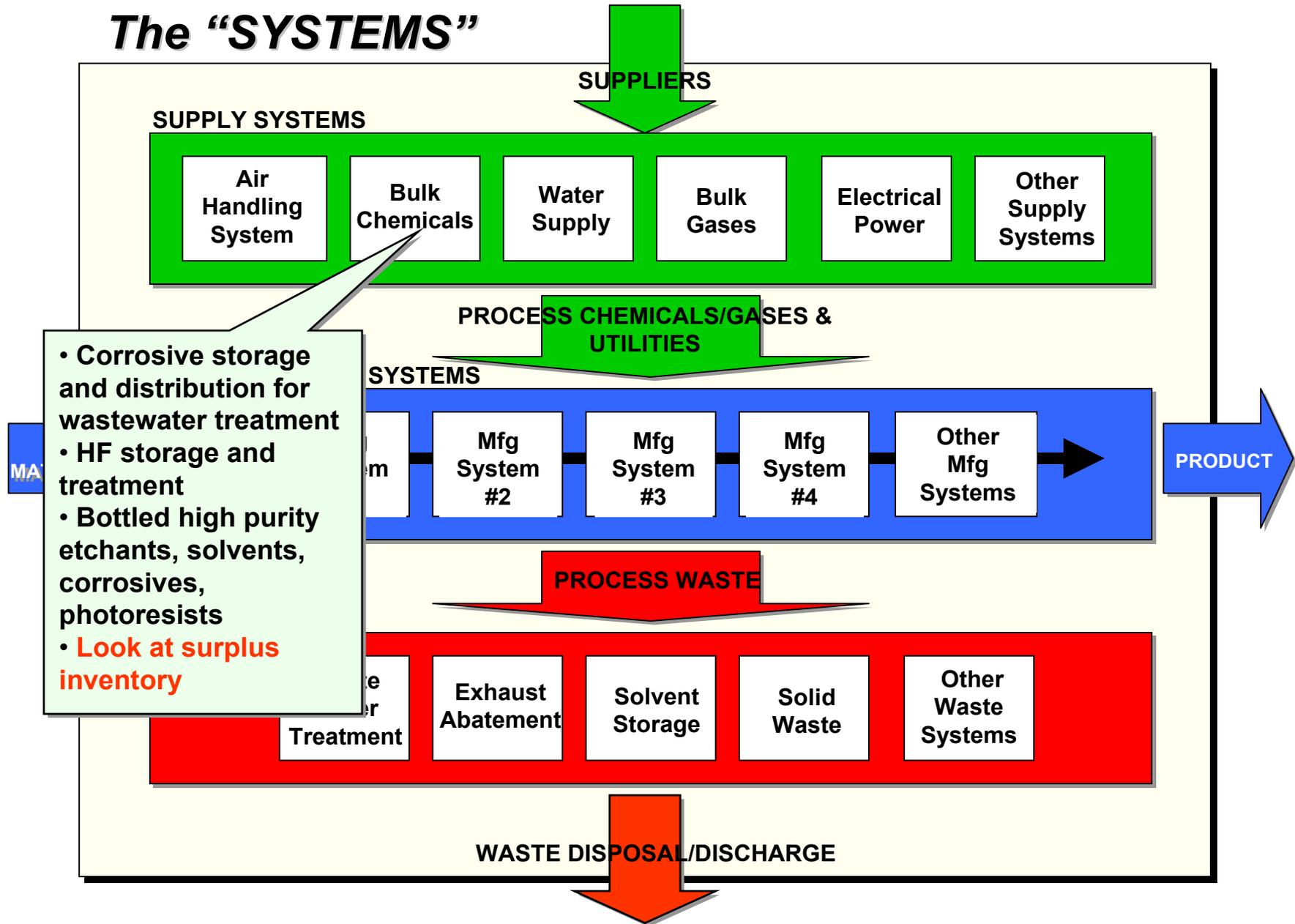
The "SYSTEMS"



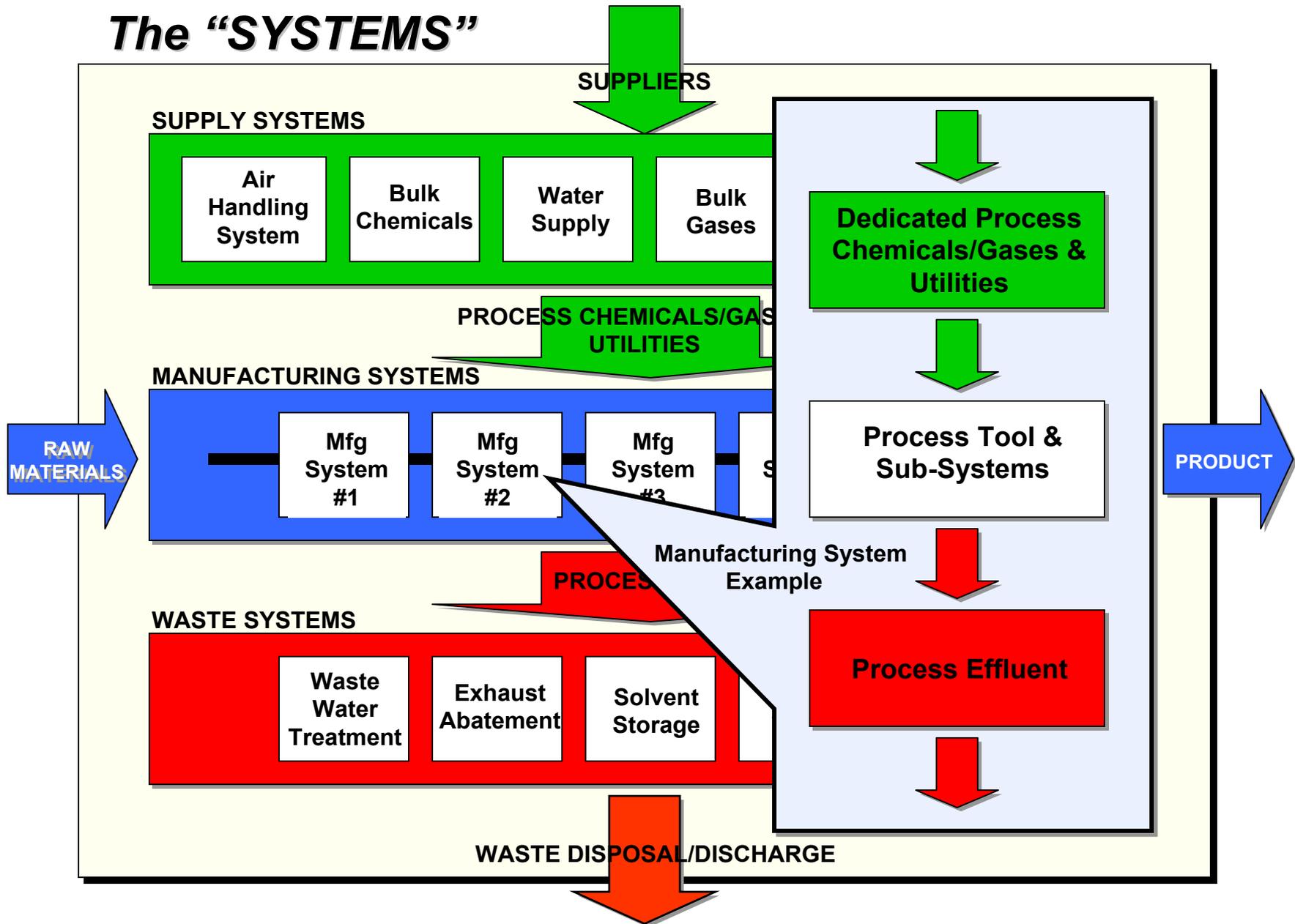
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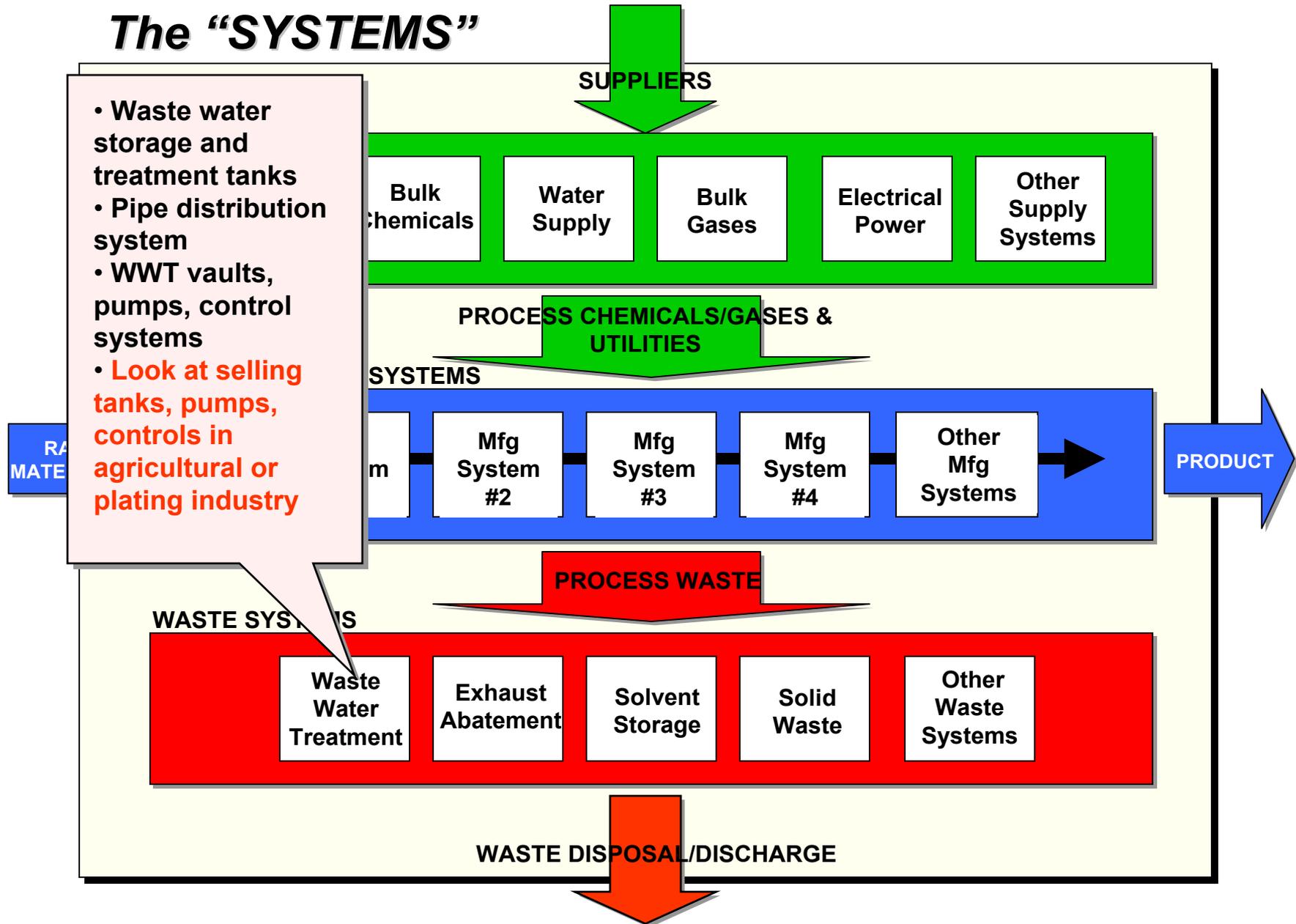
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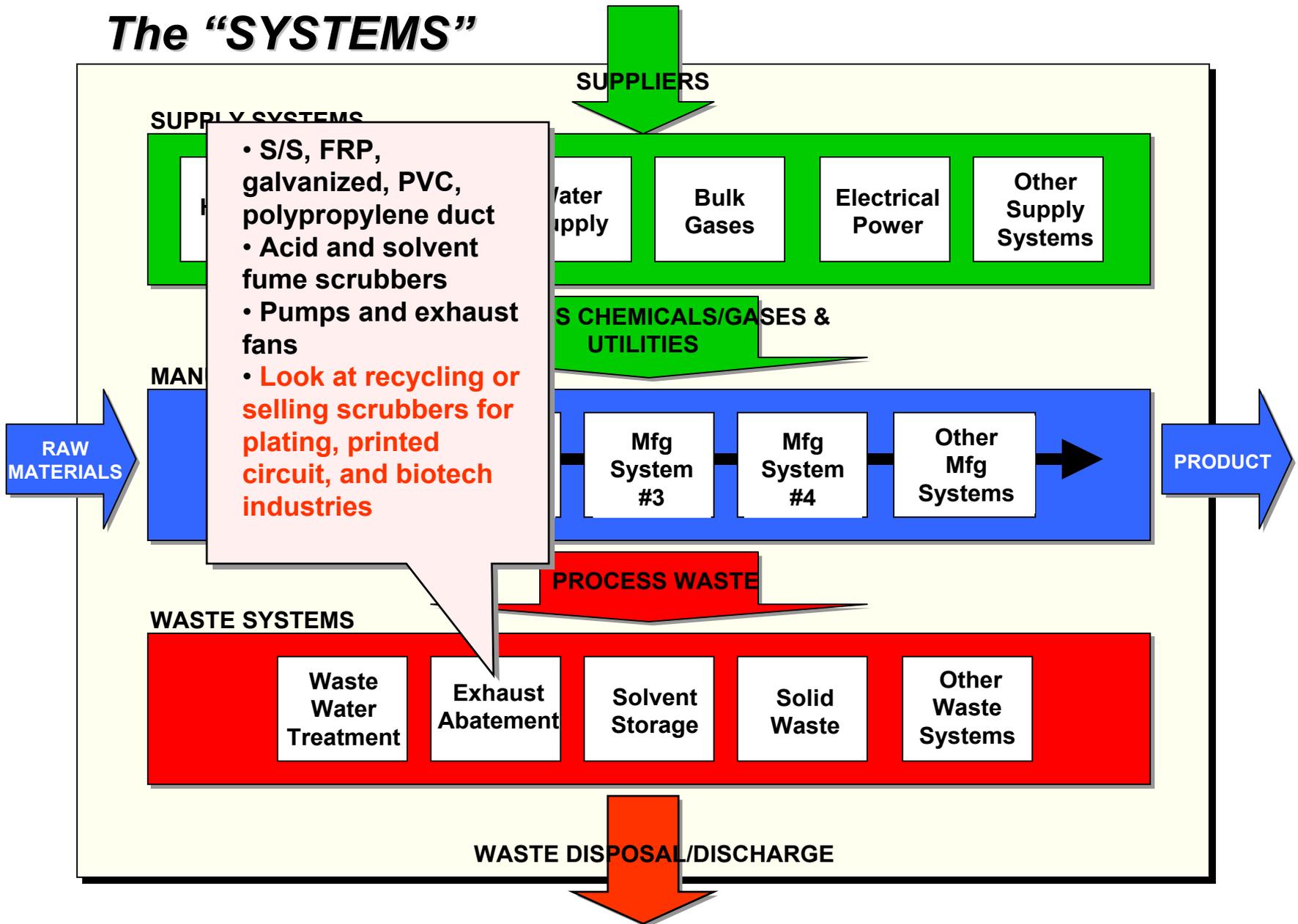
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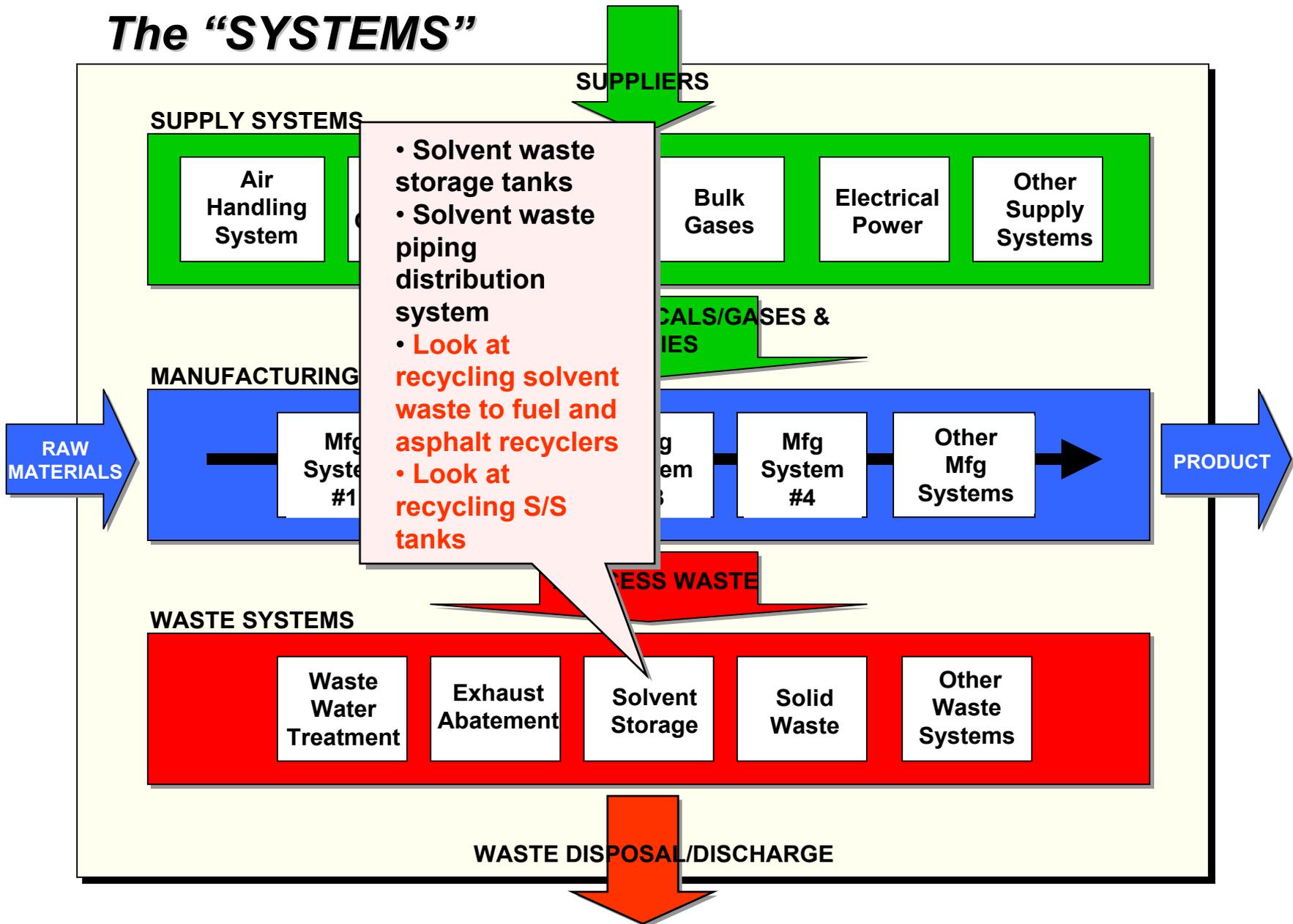
The "SYSTEMS"



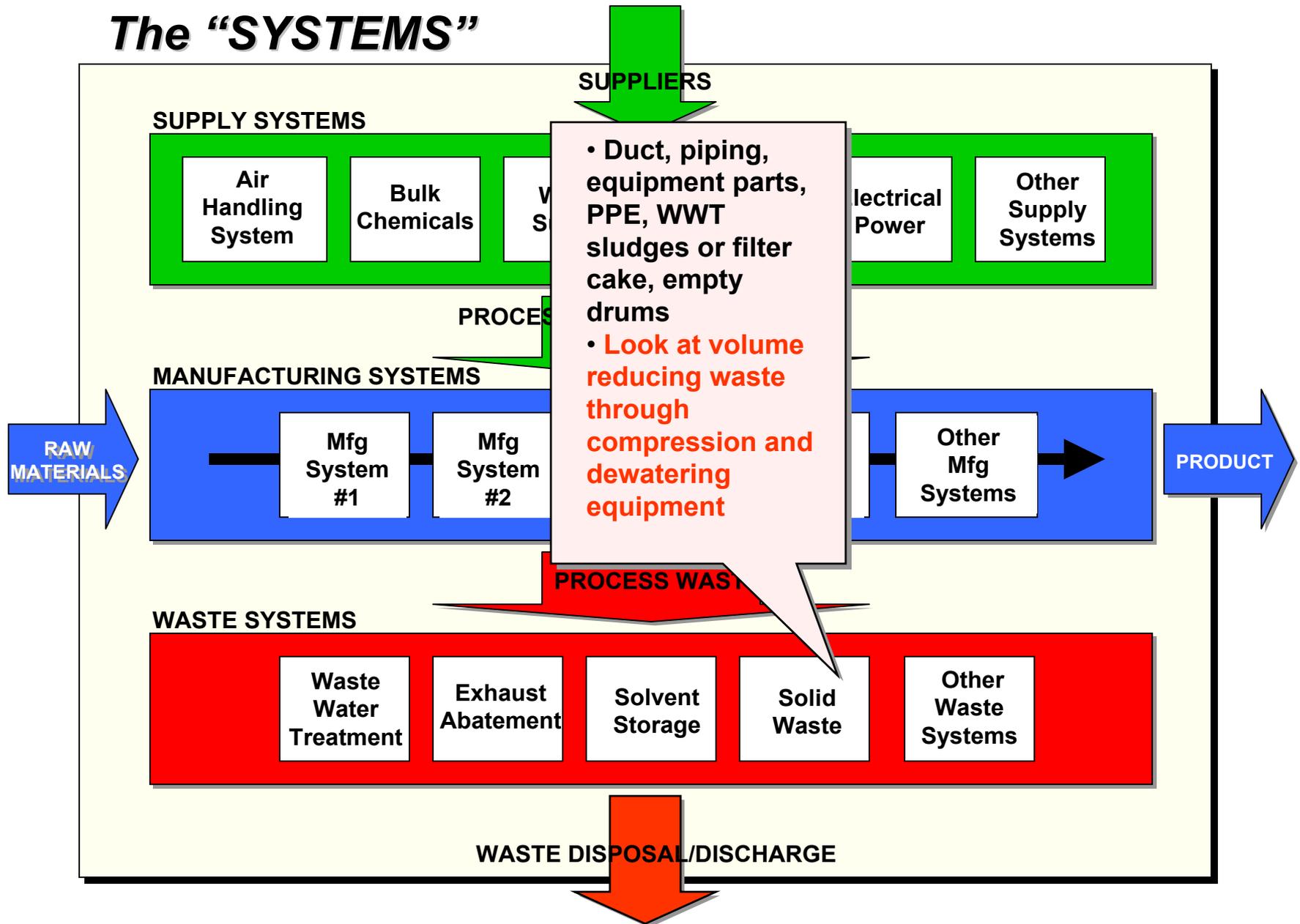
The "SYSTEMS"



The "SYSTEMS"

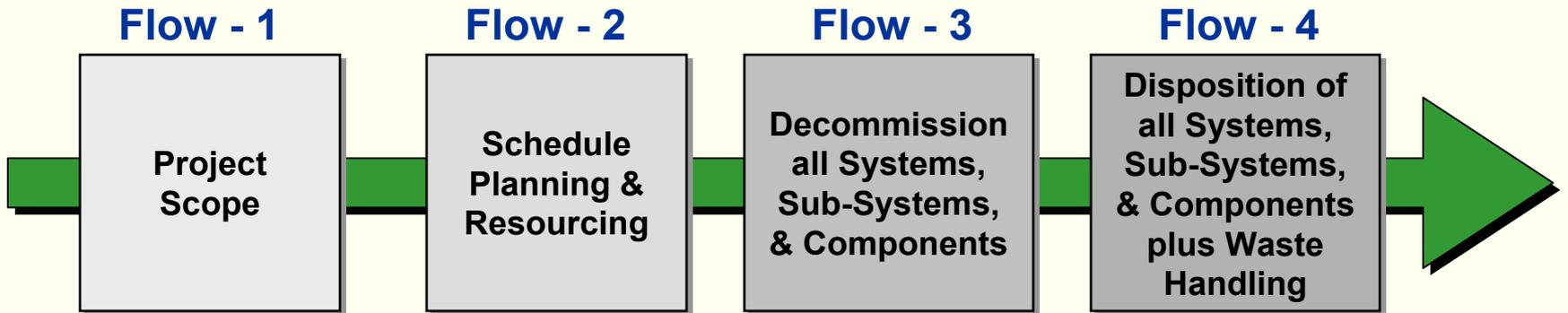


The "SYSTEMS"





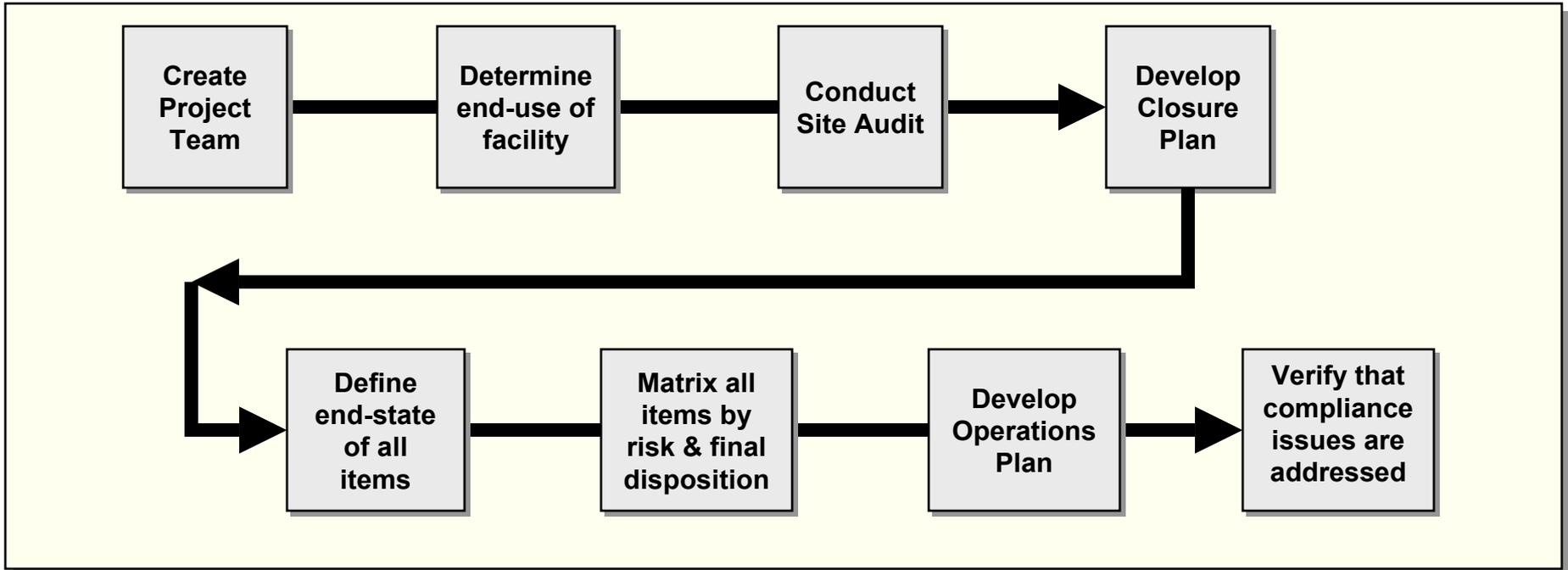
Decommissioning Process Flow





Decommissioning Process Flow - 1

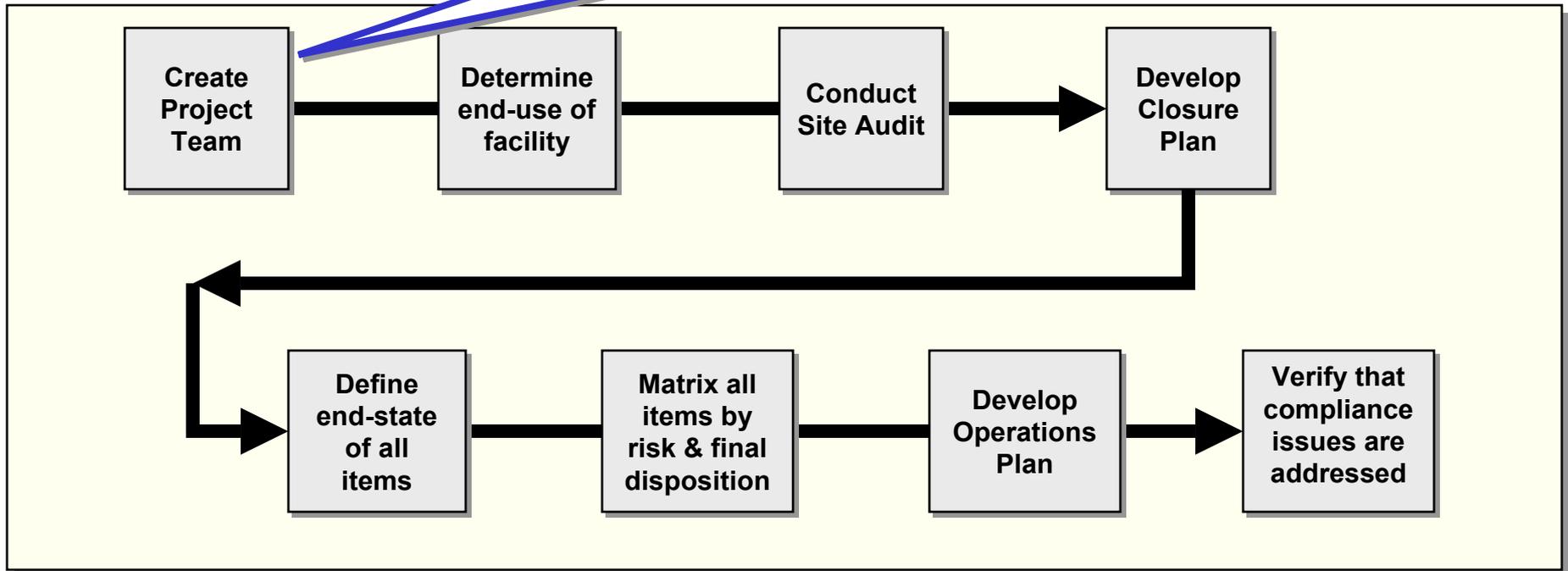
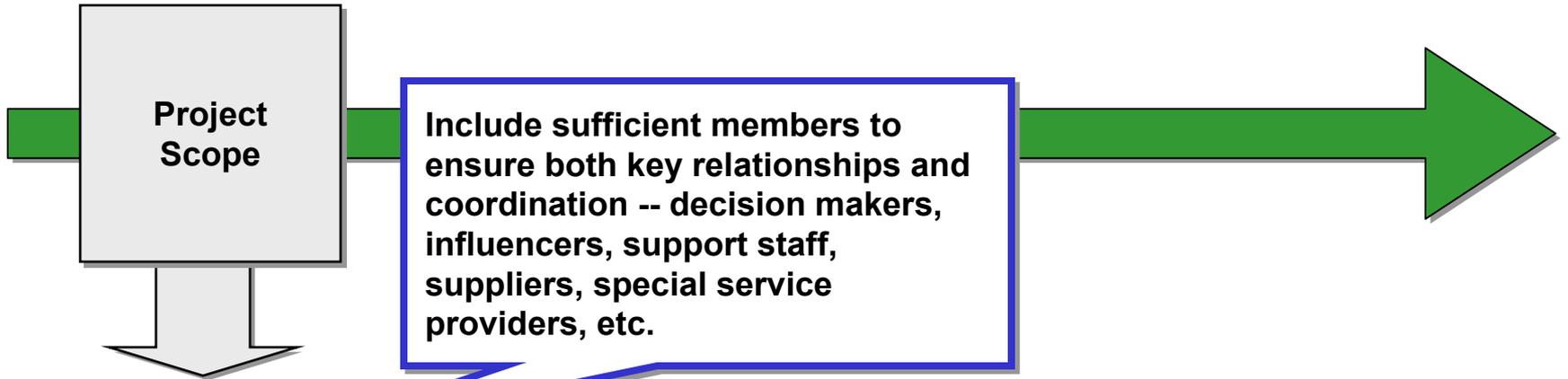
Flow-1





Decommissioning Process Flow - 1

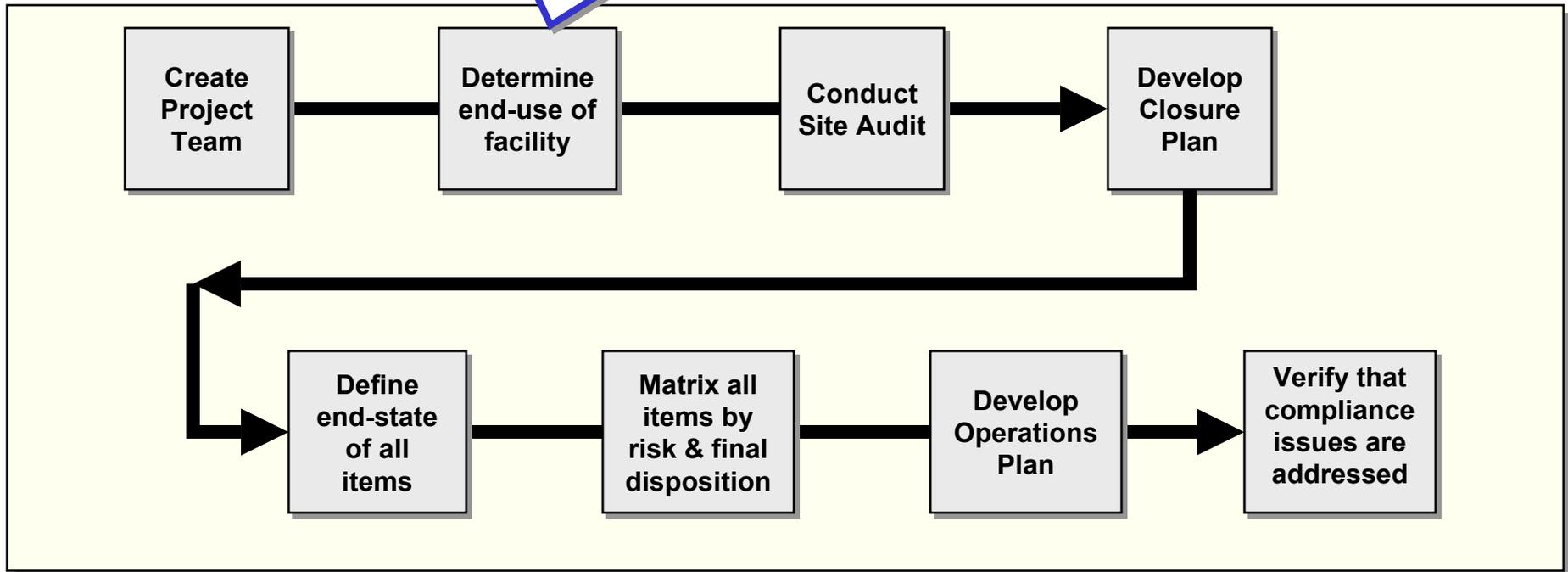
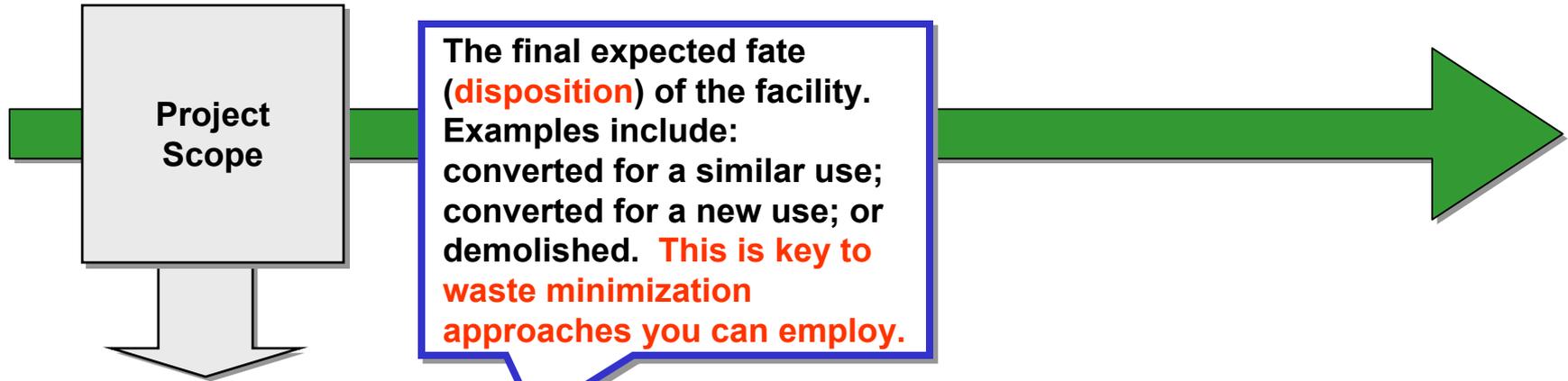
Flow-1





Decommissioning Process Flow - 1

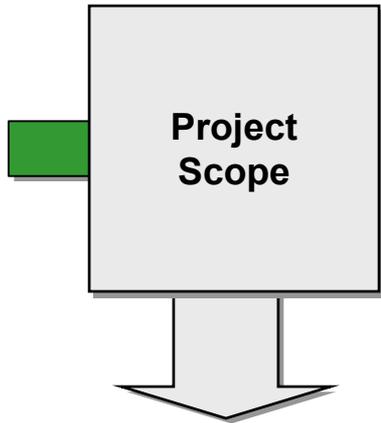
Flow-1



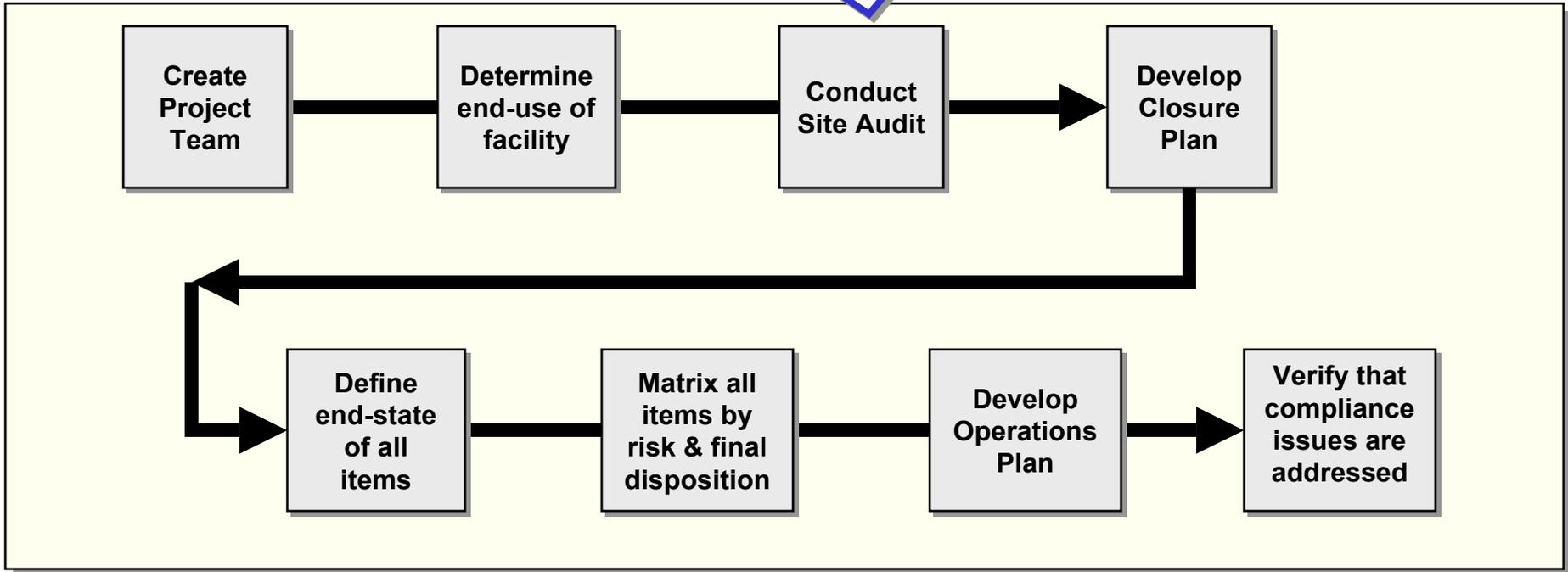


Decommissioning Process Flow - 1

Flow-1



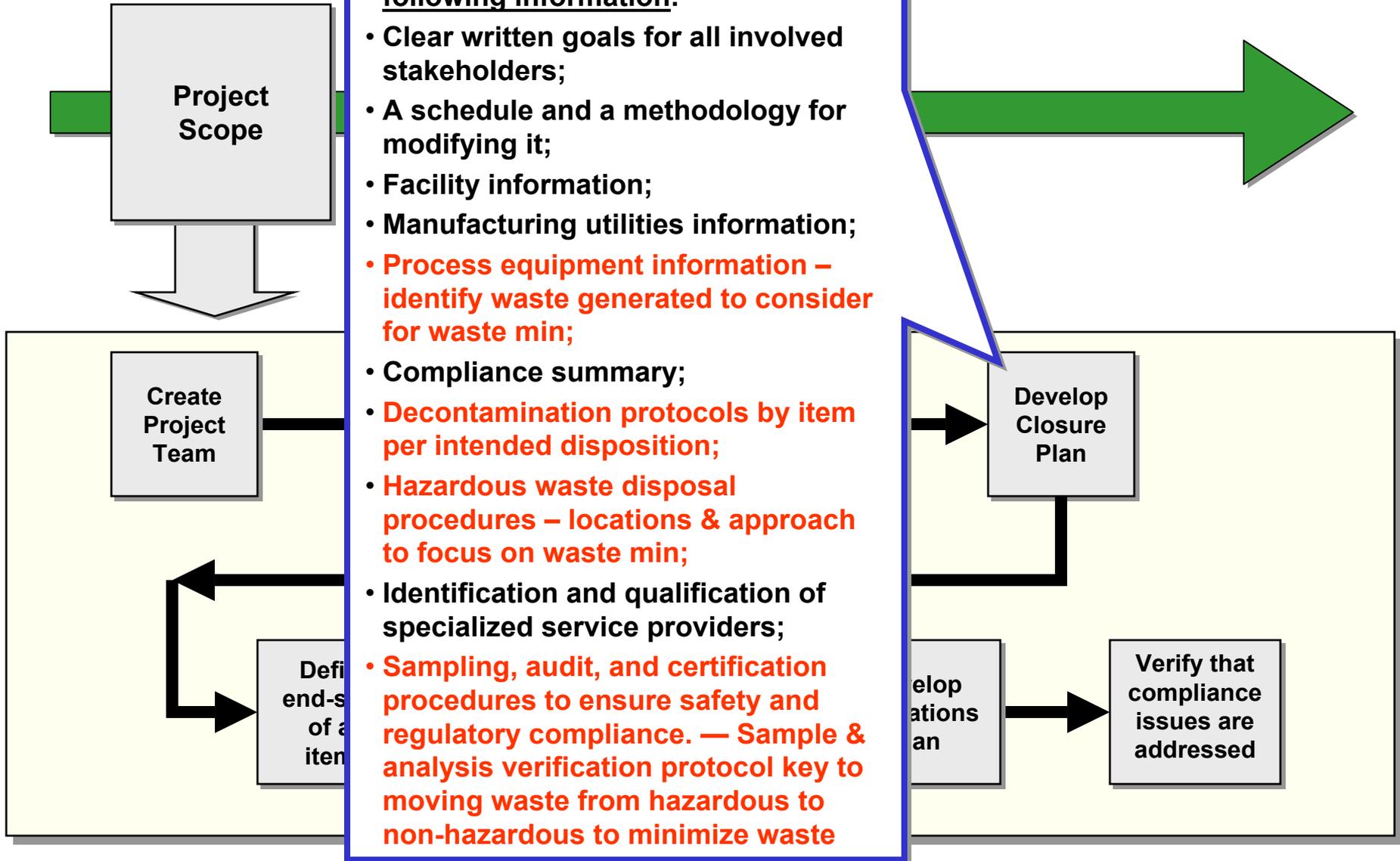
Generate a detailed list of all systems, sub-systems, and components. Locate and review all historical information for the site. **This data is invaluable throughout all processes to have cost effective waste minimization. Identify materials and waste for sale, recycling, reuse, storage, ect.**





Decommissioning Process Flow - 1

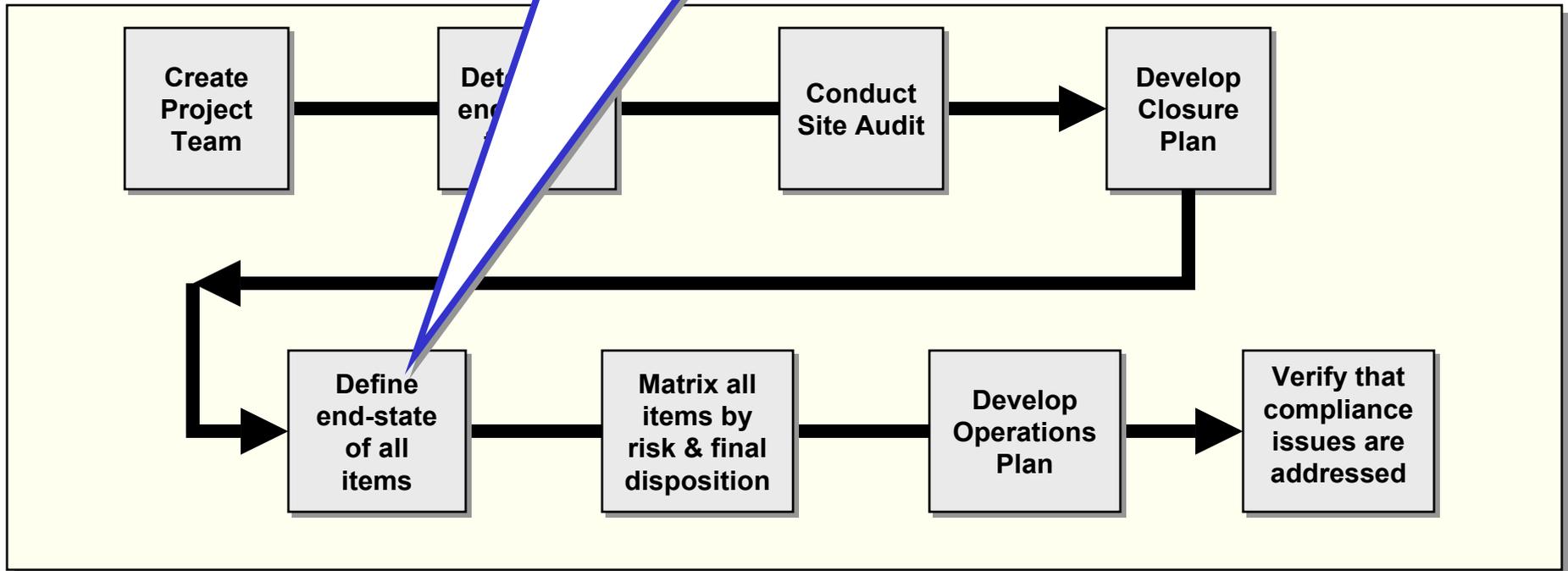
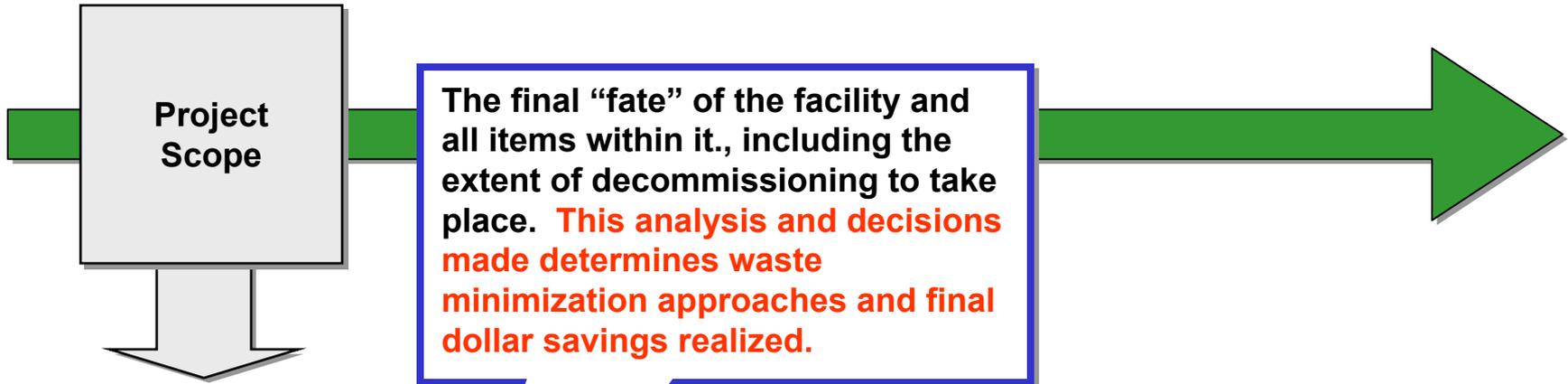
Flow-1





Decommissioning Process Flow - 1

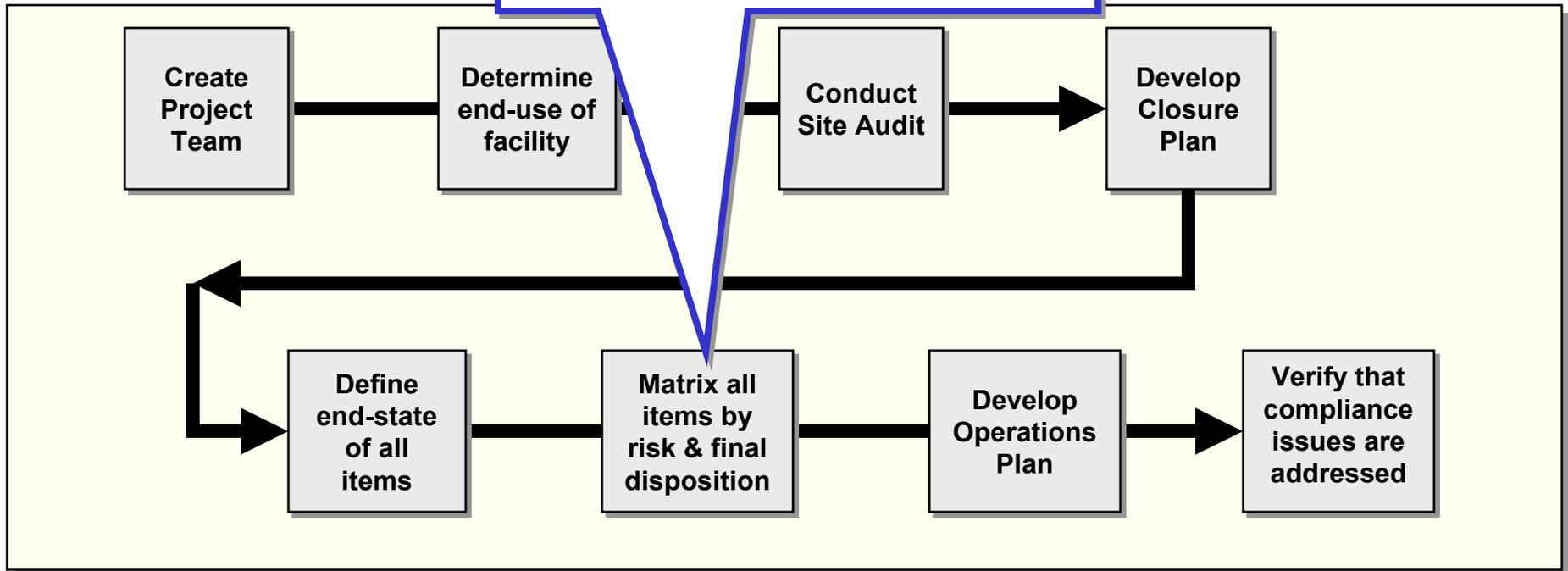
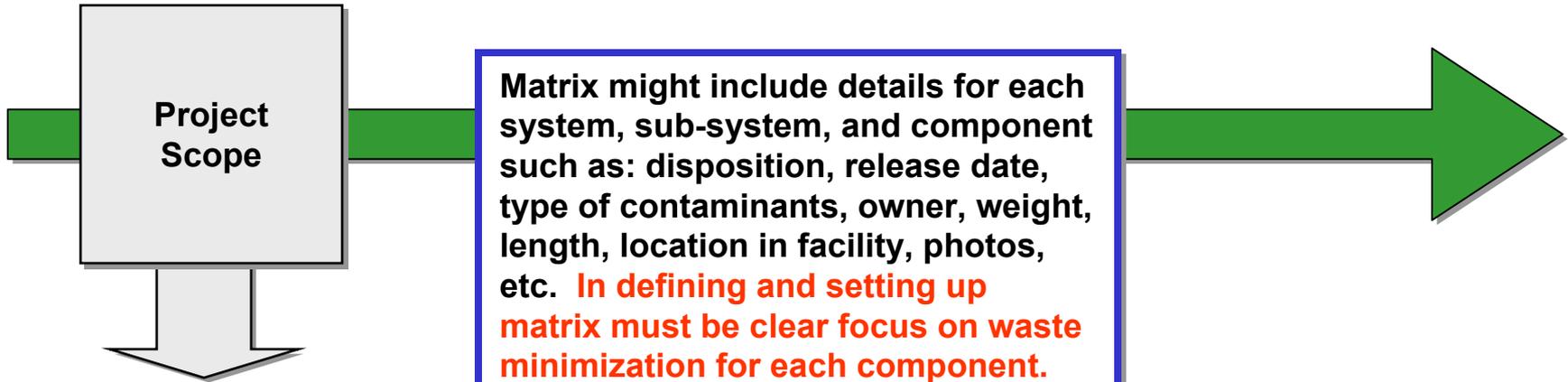
Flow-1





Decommissioning Process Flow - 1

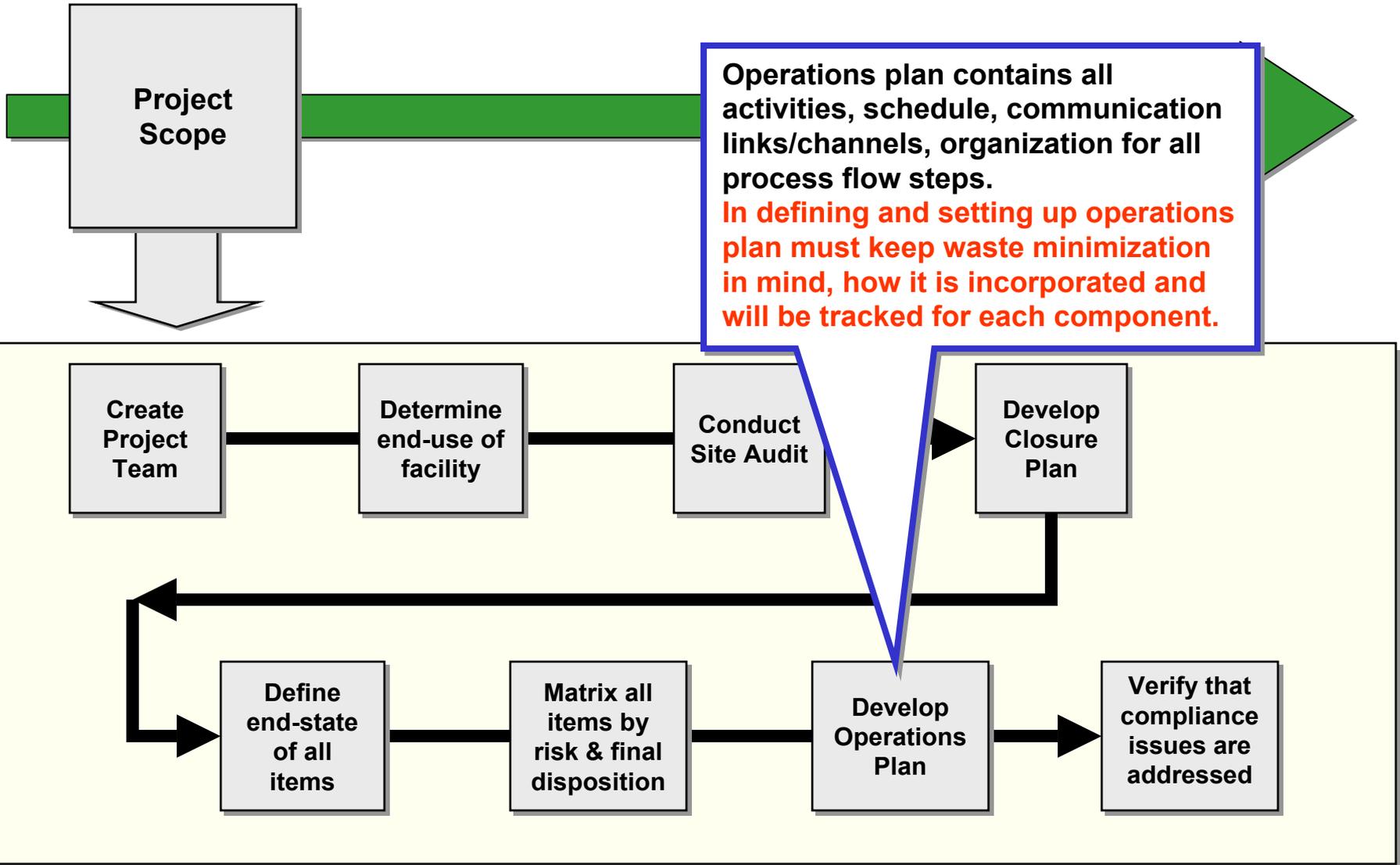
Flow-1





Decommissioning Process Flow - 1

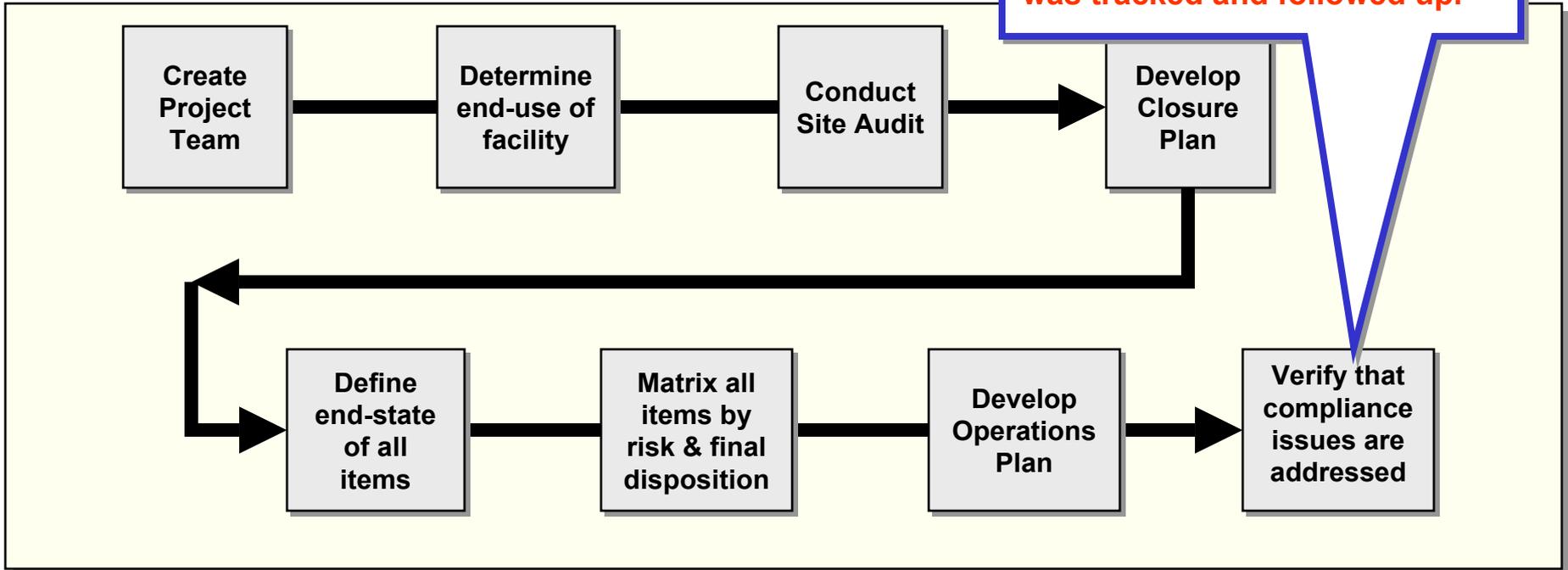
Flow-1





Decommissioning Process Flow - 1

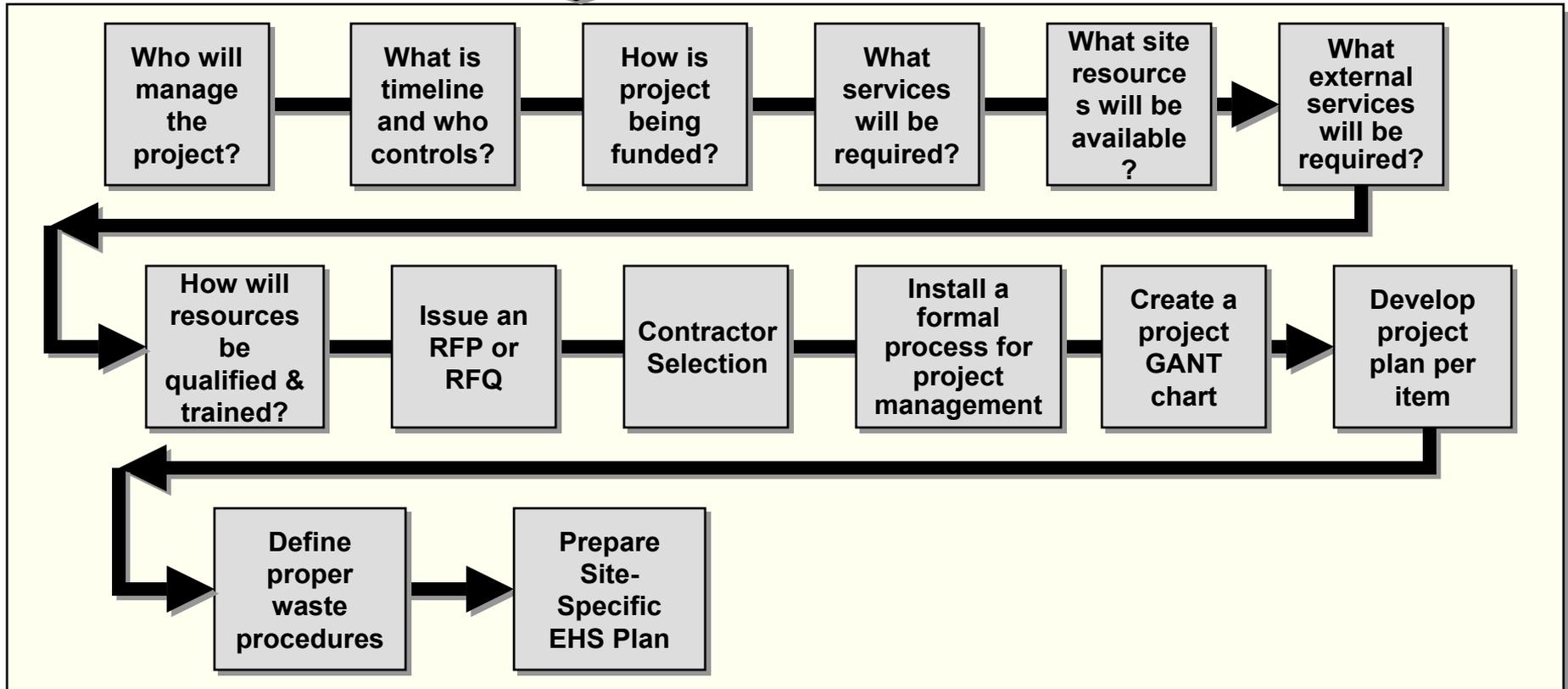
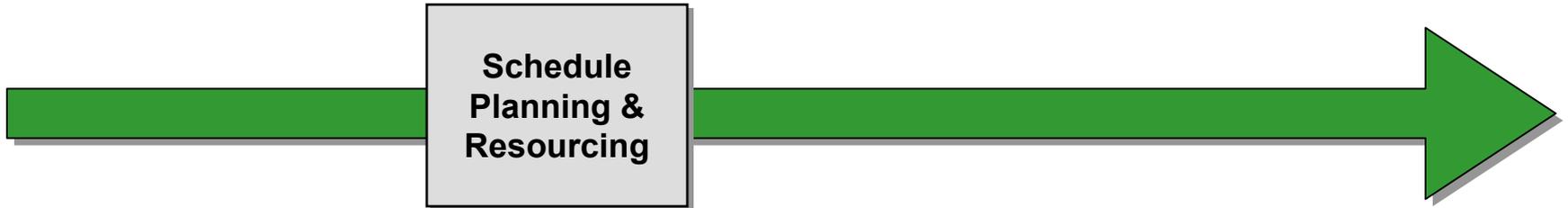
Flow-1





Decommissioning Process Flow - 2

Flow-2





Decommissioning Process Flow - 2

Flow-2

Schedule
Planning &
Resourcing

Determine the expertise and services that will be needed from current site personnel BEFORE initiating layoffs. Identify who will be needed, for what, and for how long. **Gather historical information on waste materials to maximize waste minimization.**

Who will manage the project?

What is timeline and who controls?

How is project being funded?

What services will be required?

What site resources will be available?

What external services will be required?

How will resources be qualified & trained?

Issue an RFP or RFQ

Contractor Selection

Install a formal process for project management

Create a project GANT chart

Develop project plan per item

Define proper waste procedures

Prepare Site-Specific EHS Plan



Decommissioning Process Flow - 2

Flow-2

Schedule
Planning &
Resourcing

Incorporate line item for waste material minimization, reuse, recycling, and other disposition options in plan.

Who will manage the project?

What is timeline and who controls?

How is project being funded?

What services will be required?

What site resources will be available?

What are the requirements?

How will resources be qualified & trained?

Issue an RFP or RFQ

Contractor Selection

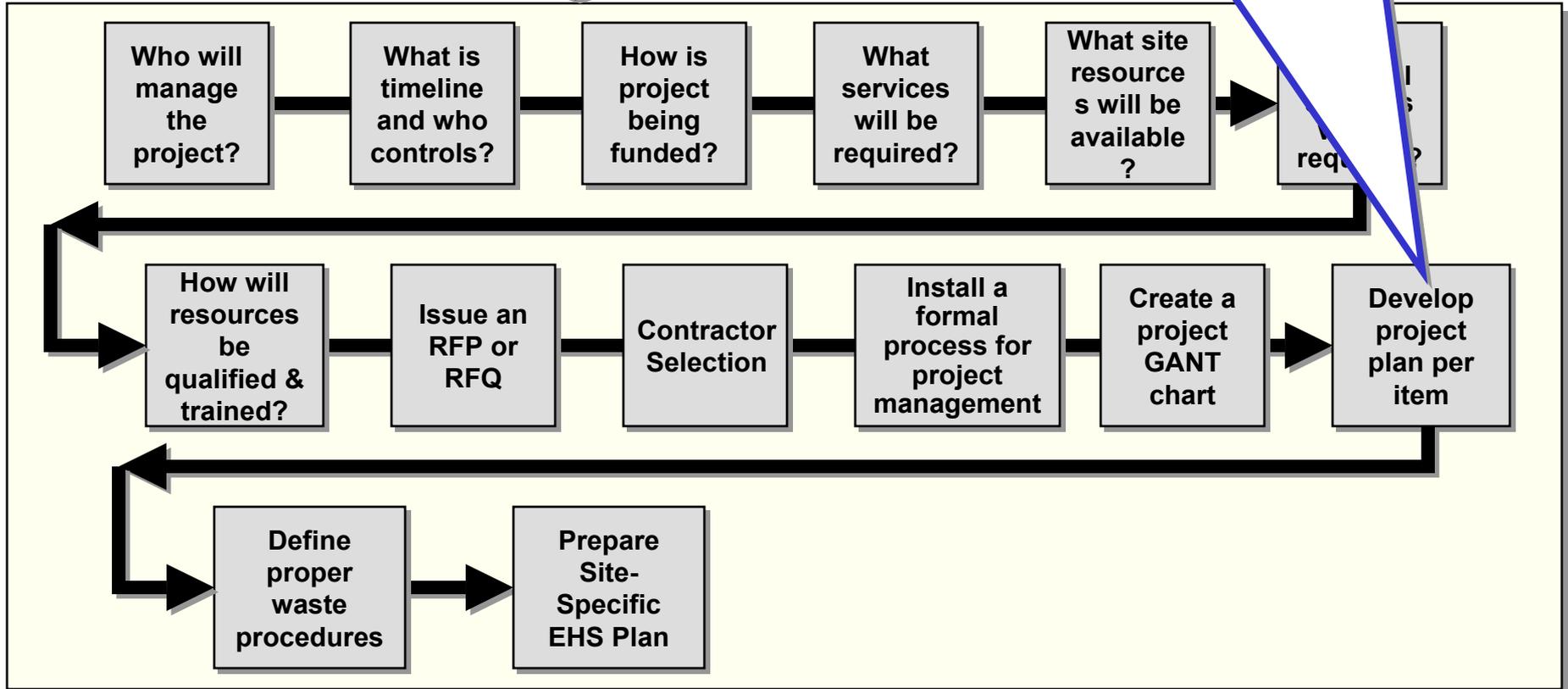
Install a formal process for project management

Create a project GANT chart

Develop project plan per item

Define proper waste procedures

Prepare Site-Specific EHS Plan





Decommissioning Process Flow - 2

Flow-2

Schedule
Planning &
Resourcing

This step includes waste identification, classification, characterization, decontamination, segregation, packaging, labeling, site selection, and volume reduction tasks that can render the waste saleable, reusable, recyclable.

The dollar savings realized in waste minimization are maximized or lost in this step.

is
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g
d?

What
services
will be
required?

What site
resource
s will be
available
?

What
external
services
will be
required?

qu
tra

Issue an
RFP or
RFQ

Contractor
Selection

Install a
formal
process for
project
management

Create a
project
GANT
chart

Develop
project
plan per
item

Define
proper
waste
procedures

Prepare
Site-
Specific
EHS Plan



Decommissioning Process Flow - 2

Flow-2

Schedule
Planning &
Resourcing

Who will
manage
the
project?

What is
timeline
and who
controls?

How is
project
being
funded?

Wh
servi
will
requi

How will
resources
be
qualified &
trained?

Issue an
RFP or
RFQ

Contractor
Selection

Define
proper
waste
procedures

Prepare
Site-
Specific
EHS Plan

Selected contractor develops a project-specific EHS plan which meets all applicable EHS regulatory requirements including the elements listed below:

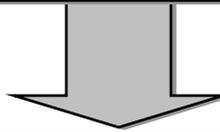
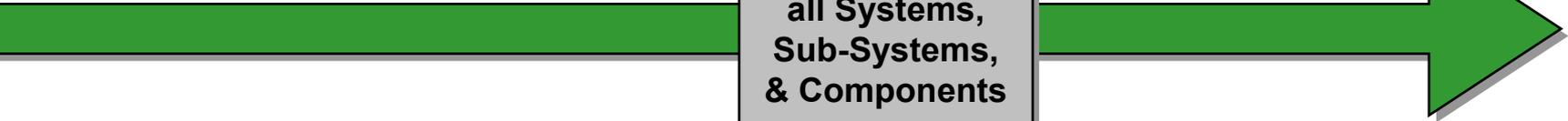
- Hazard specific EHS training;
- **Task specific demolition, decontamination procedures focused on waste minimization;**
- Job hazard analysis (JHA) for all construction related tasks;
- **Leading indicator programs; Setup indicators to initiate segregating materials & waste for recycling, reuse, volume reduction, disposal**
- **A housekeeping plan; Prevents unnecessary waste being disposed of rather than minimized**
- A disciplinary action plan;
- Incident reporting and investigation;
- A return-to-work program;
- A new employee training program (buddy program); and
- A project readiness plan.



Decommissioning Process Flow - 3

Flow - 3

Decommission
all Systems,
Sub-Systems,
& Components



Decommission
each item per
procedures

Perform
in-place decon
per item plan

Complete
required
documentation
& affix labels

Review
each
item's
final
status

Demolition
as
required
per
procedure





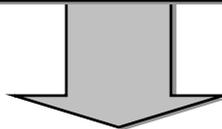
Decommissioning Process Flow - 3

Decommissioning spans from pre-disconnect activities and drawing verifications to disconnecting tools from utilities and disassociating all items from other manufacturing systems.

This task should be carefully planned and tracked to capture all the waste materials generated from the systems to obtain maximum waste minimization.

Flow - 3

Decommission all Systems, Sub-Systems, & Components



Decommission each item per procedures

Perform in-place decon per item plan

Complete required documentation & affix labels

Review each item's final status

Demolition as required per procedure





Decommissioning Process Flow - 3

Decontamination procedures and verification sampling & analysis protocol for each in-place tool, piece of equipment and facility area is paramount to performing this task;

Clean, segregate, and size reduce exhaust duct, process pipe, and equipment parts for metals, plastic to reuse and recycle is critical to effectively minimizing waste

Flow - 3

Decommission all Systems, Sub-Systems, & Components



Decommission each item per procedures

Perform in-place decon per item plan

Complete required documentation & affix labels

Review each item's final status

Demolition as required per procedure





Decommissioning Process Flow - 3

Starting with original site audit matrix all waste must be documented and tracked throughout the whole decommissioning processes.

Use color coded labels to identify requirements and materials that are reusable, size reducible, recyclable for achieving waste minimization objectives.

Flow - 3

Decommission all Systems, Sub-Systems, & Components



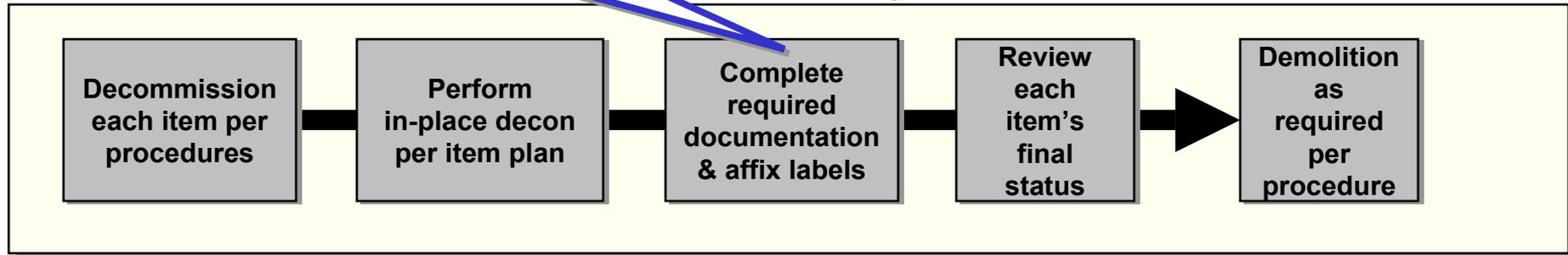
Decommission each item per procedures

Perform in-place decon per item plan

Complete required documentation & affix labels

Review each item's final status

Demolition as required per procedure





Decommissioning Process Flow - 3

Flow - 3

Decommission
all Systems,
Sub-Systems,
& Components

Review and check with the plans each system, subsystem and their components starting at beginning of process to the end of the items life cycle; **Confirm each item that is to be handled during decommissioning and decontamination for waste minimization is in fact being executed properly.**

Decommission
each item per
procedures

Perform
in-place decon
per item plan

Complete
required
documentation
& affix labels

Review
each
item's
final
status

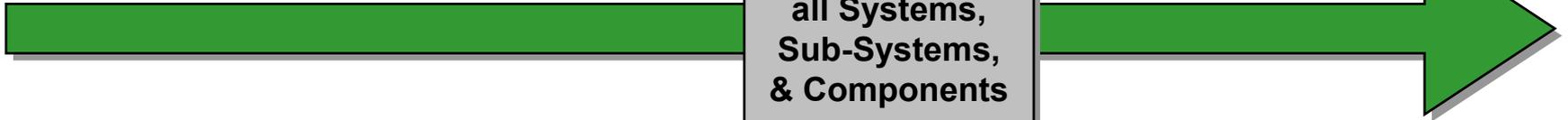
Demolition
as
required
per
procedure



Decommissioning Process Flow - 3

Flow - 3

Decommission
all Systems,
Sub-Systems,
& Components



Demolition activities include system, sub-system, or component disconnection, support cable pulling, tool move, and tool utility demolition back to point of facility interface.

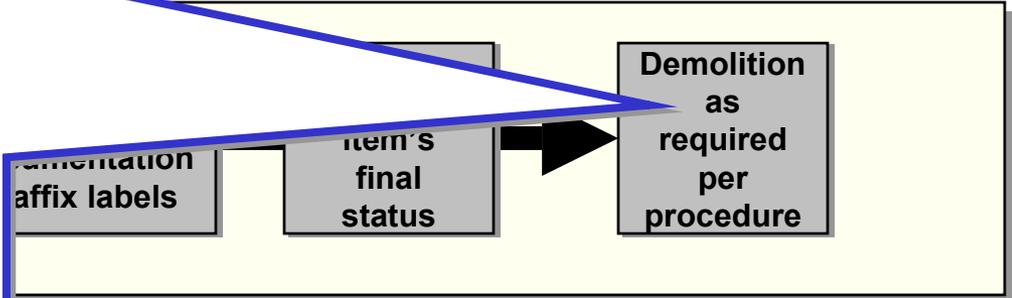
Segregate debris and materials during demo that are reusable and recyclable that can be waste minimized;
Align waste streams and demo debris with matrix of risk and final disposition;
Track to make sure it is handled properly;

Decommission
each item
per procedure

Documentation
affix labels

Item's
final
status

Demolition
as
required
per
procedure

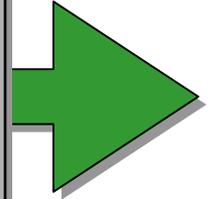




Decommissioning Process Flow - 4

Flow - 4

Disposition of all Systems, Sub-Systems, & Components plus Waste Handling



Reference the item disposition matrix

Coordinate with certified HazMat shipper

Prepare to ship all items

Prepare all wastes for proper shipping & disposal

Execute disposition plan

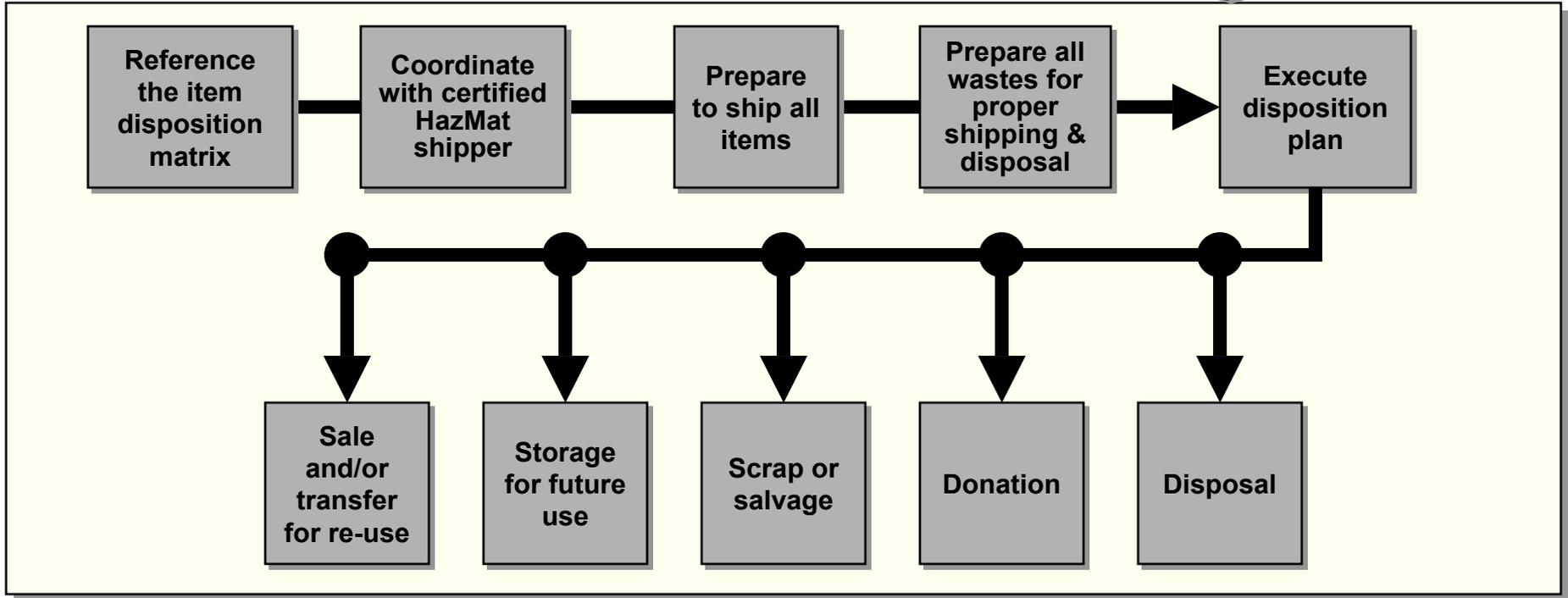
Sale and/or transfer for re-use

Storage for future use

Scrap or salvage

Donation

Disposal



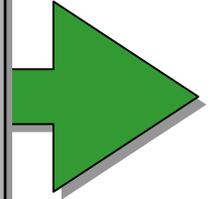


Decommissioning Process Flow - 4

Flow - 4

Check and double-check disposition matrix developed during audit and planning steps to make sure waste minimization objectives are being executed fully.

Disposition of all Systems, Sub-Systems, & Components plus Waste Handling



Reference the item disposition matrix

Coordinate with certified HazMat shipper

Prepare to ship all items

Prepare all wastes for proper shipping & disposal

Execute disposition plan

Sale and/or transfer for re-use

Storage for future use

Scrap or salvage

Donation

Disposal

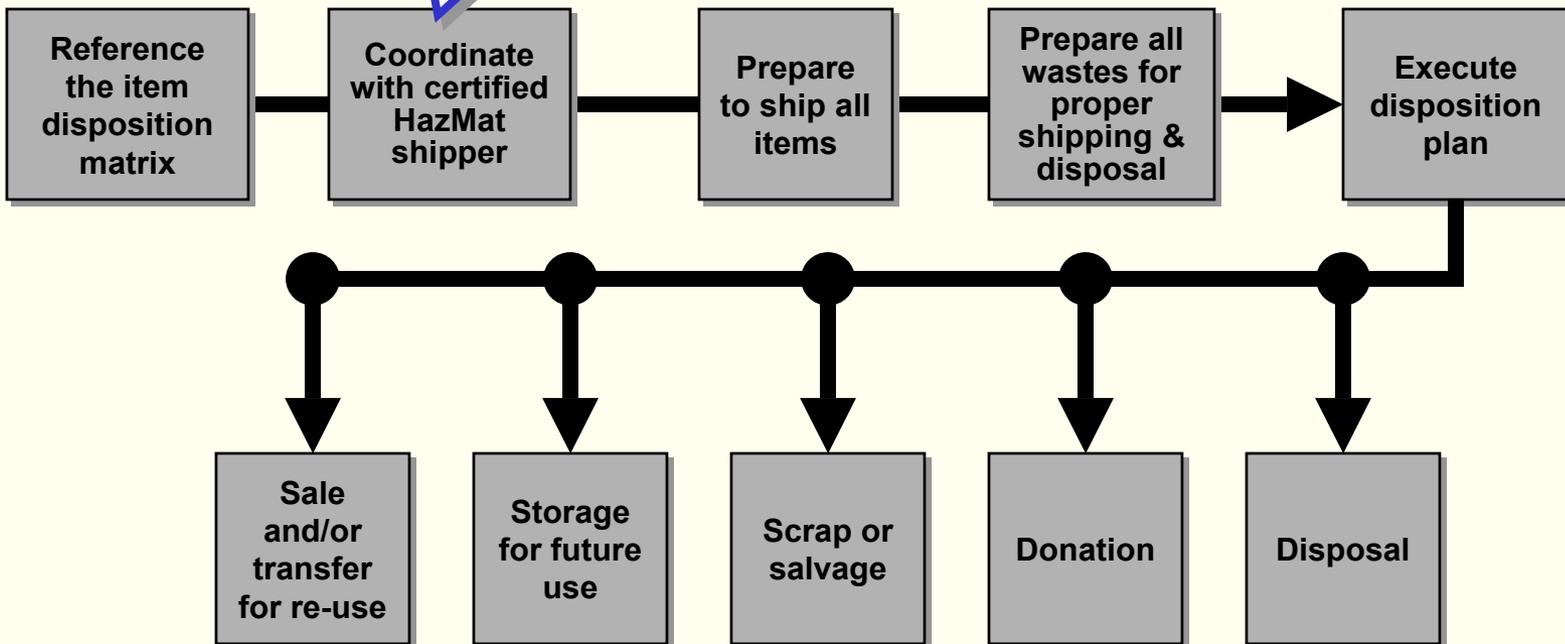
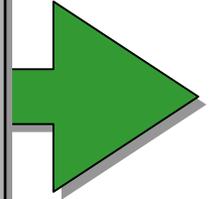


Decommissioning Process Flow - 4

Flow - 4

Check DOT licenses, training records of employees, insurance coverage, and other client references before hiring shippers.
Check scrap and recycling facility permits and capabilities to take advantage of reuse and recycling savings.

Disposition of all Systems, Sub-Systems, & Components plus Waste Handling



Origin Services:

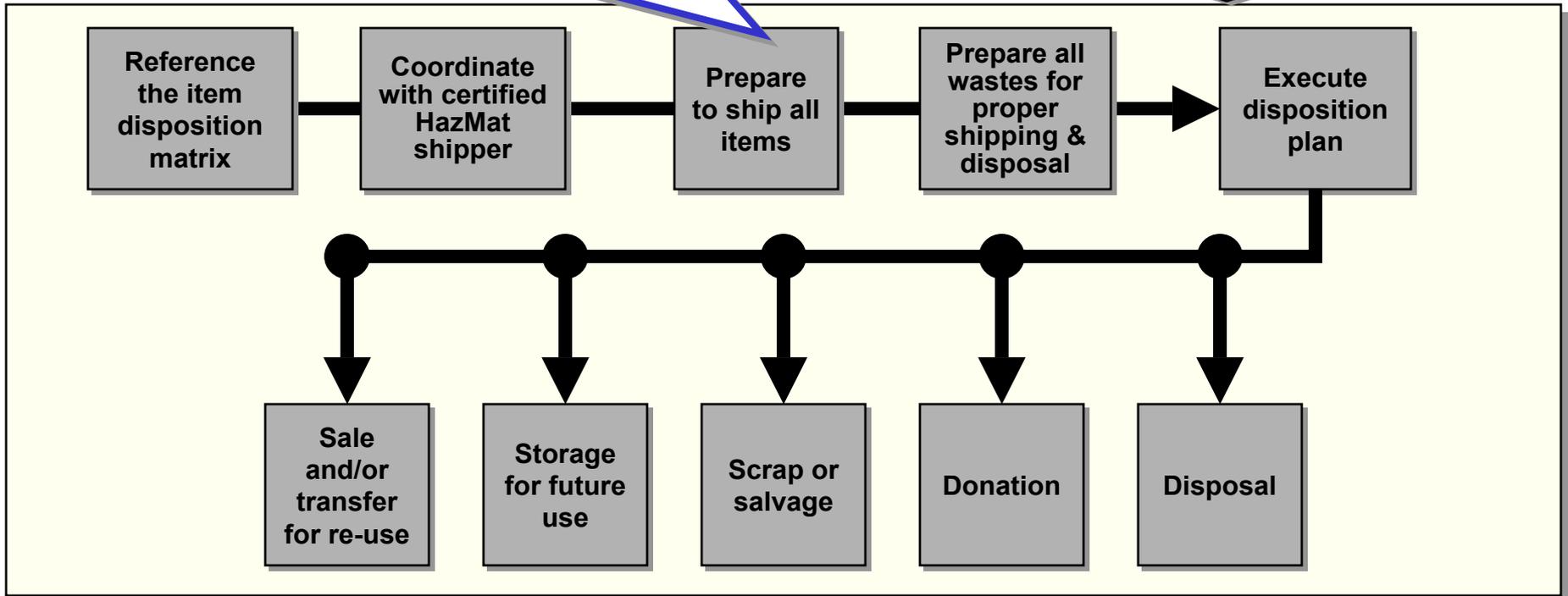
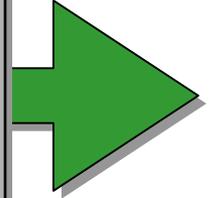
- Package item per spec to prevent against leakage or contamination.
- Coordinate removal and rigging (may include contracting disassembly of systems).
- Export packing and crating (for immediate shipment or storage).
- All risk cargo transit insurance, if required.
- Preparation of shipping and export documentation.
- Outbound shipment by air and/or sea.

Confirm all waste & recycled or reused materials are packaged to meet DOT & Int'l requirements/laws

g Process Flow - 4

Flow - 4

Disposition of all Systems, Sub-Systems, & Components plus Waste Handling



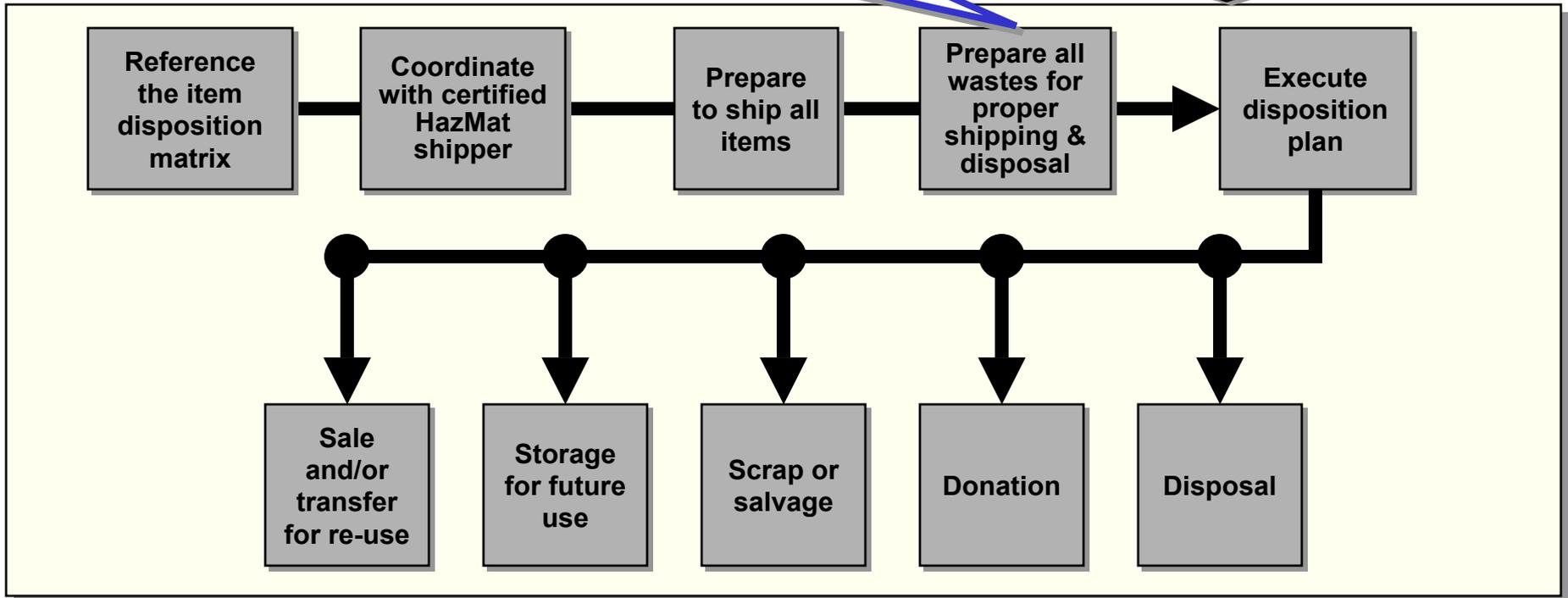


Decommissioning Process Flow - 4

- Profile waste or recyclable/scrap materials with facility
 - Prepare manifests, shipping documents – generator sign paperwork
 - Schedule disposal or recycling site receiving date
 - Request certificate of destruction for waste incinerated
- Audit final destination disposal or recycling facility.
Check scrap and recycling facility permits and capabilities
to take advantage of reuse and recycling savings.**

Flow - 4

Disposition of
all Systems,
Sub-Systems,
& Components
plus Waste
Handling





Decommissioning Process Flow - 4

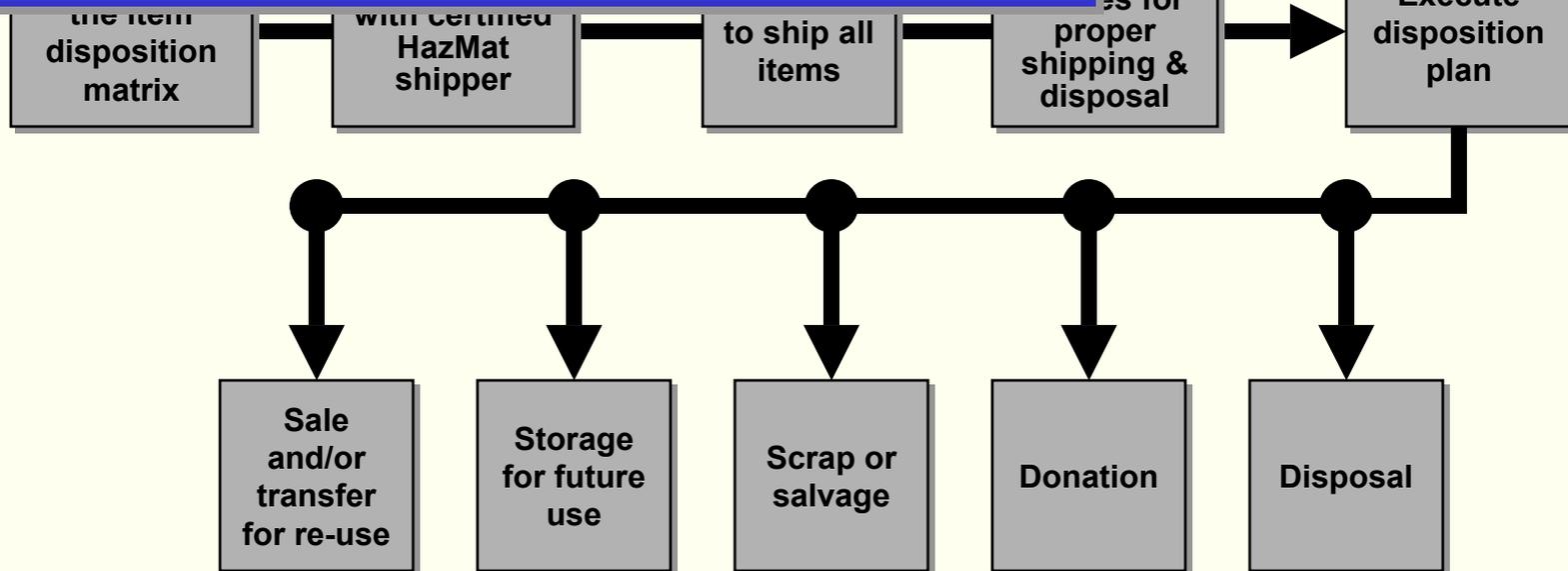
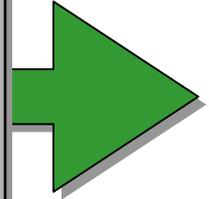
Destination Services:

- Assistance with and coordination of import permit documentation (as applicable).
- Import and customs clearance services at arrival port.
- Facilitation of import duty payments.
- Warehousing upon arrival, if required.
- Delivery to destination sites as required to meet production schedules.
- Coordination of delivery and/or rigging at destination site, as required.

Confirm any waste materials or equipment is recycled or reused to maximize waste minimization

Flow - 4

Disposition of all Systems, Sub-Systems, & Components plus Waste Handling





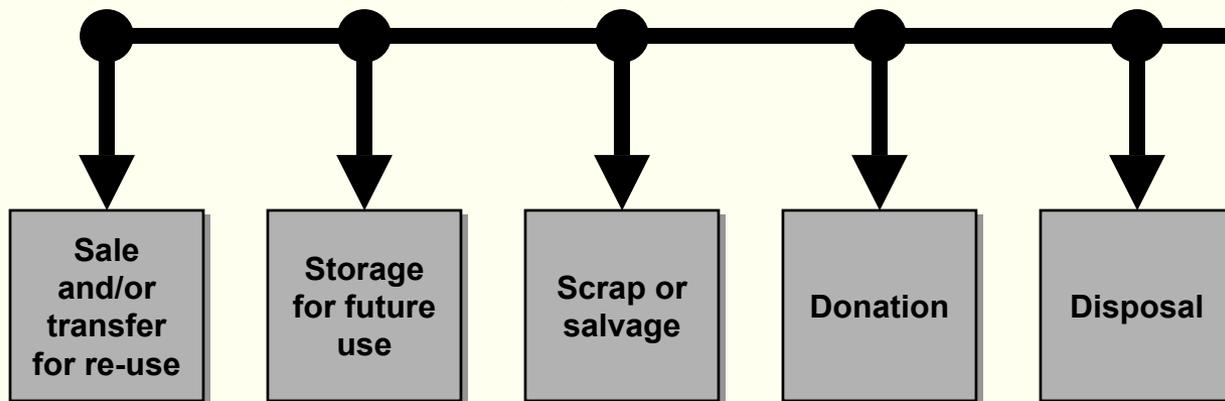
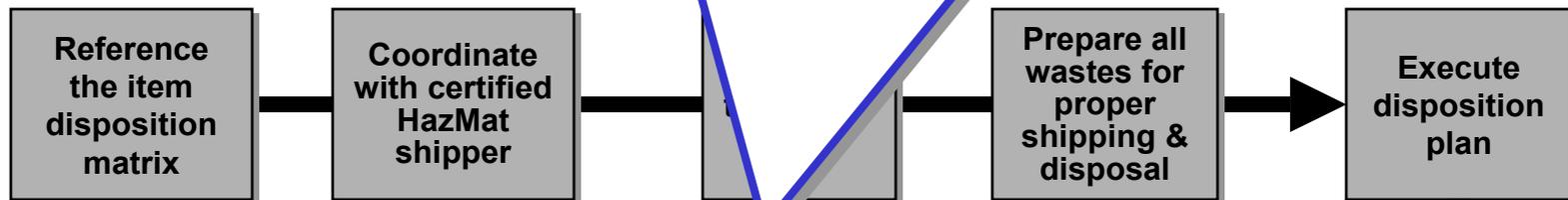
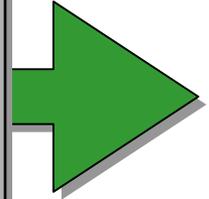
Decommissioning Process Flow - 4

There is no single decontamination answer for an entire project. The degree of decontamination required is a function of the item's intended **disposition**.

Decontamination and sampling and analysis verification protocols should be designed based upon each item's prior process exposure, intended disposition, and whether or not a return to process is required.

Flow - 4

Disposition of all Systems, Sub-Systems, & Components plus Waste Handling





Verification Wipe Sampling Protocol

- ❑ **DECON developed wipe sampling verification protocol for facility closures**
- ❑ **Satisfies regulators for equipment or facility closure when compared to Federal, State, Local regulatory standards (Federal WET, TCLP; CA TTLC, STLC, etc.)**
- ❑ **Formula used is based on determining chemical constituent concentration amount on surfaces with a discrete thickness and known density**
- ❑ **Final wipe sample result calculated is mg/kg or ppm**
- ❑ **Result compares to most regulatory standards for hazardous waste characterization**
- ❑ **Result provides verification that the surface has been decontaminated to the acceptable regulatory or company-standard chemical constituent concentration**





Decommissioning Process Flow - 4

Flow - 4

- Include in transfer for reuse or sale of assets the transfer of ownership with acceptance of Decontamination Declaration Statement and backup information (analytical methods, data, and procedures performed, date performed, calculations converting wipe sample to kg/mg or ppm, comparison tables with cleanup criteria set to regulatory standards or client guidelines)
- Include list of previously used chemicals in system, subsystem, or facility area.

Savings from waste minimization in the sale/reuse process is dependent on following these steps.

Disposition of all Systems, Sub-Systems, & Components plus Waste Handling

Prepare all wastes for proper shipping & disposal

Execute disposition plan

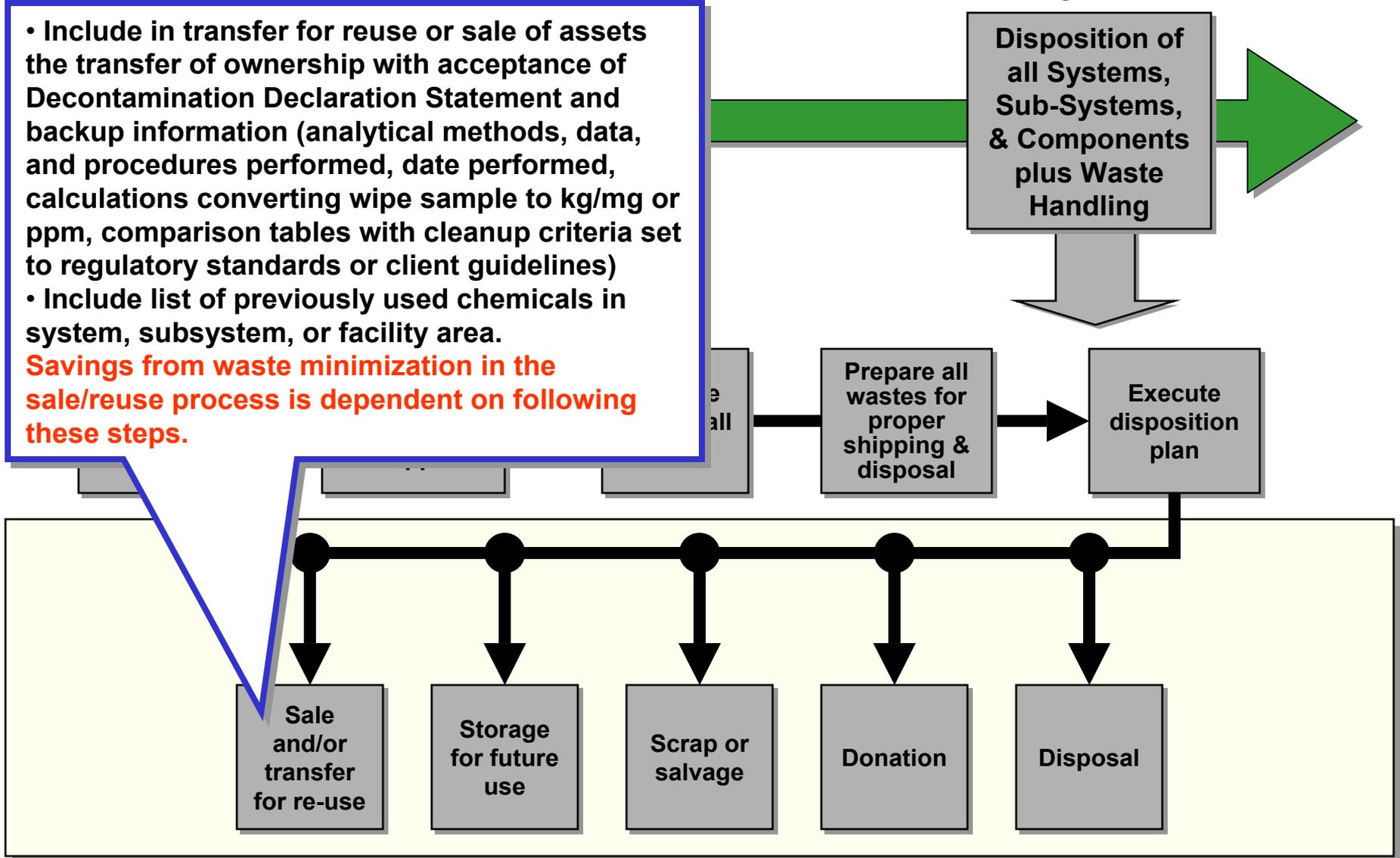
Sale and/or transfer for re-use

Storage for future use

Scrap or salvage

Donation

Disposal



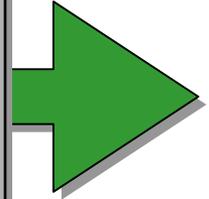


Decommissioning Process Flow - 4

- Purge, clean and cap systems, subsystems, and components
- Equipment systems, subsystems, and components that are decontaminated should have an attached Decontamination Declaration signed by previous owner, tool engineer responsible for tool, responsible EH&S manager, and the decon contractor's responsible representative
- **It is critical in terms of future waste minimization that records of this step be secured and accessible to owners**

Flow - 4

Disposition of all Systems, Sub-Systems, & Components plus Waste Handling



Prepare all items

Prepare all wastes for proper shipping & disposal

Execute disposition plan

Disposition matrix

Disposition

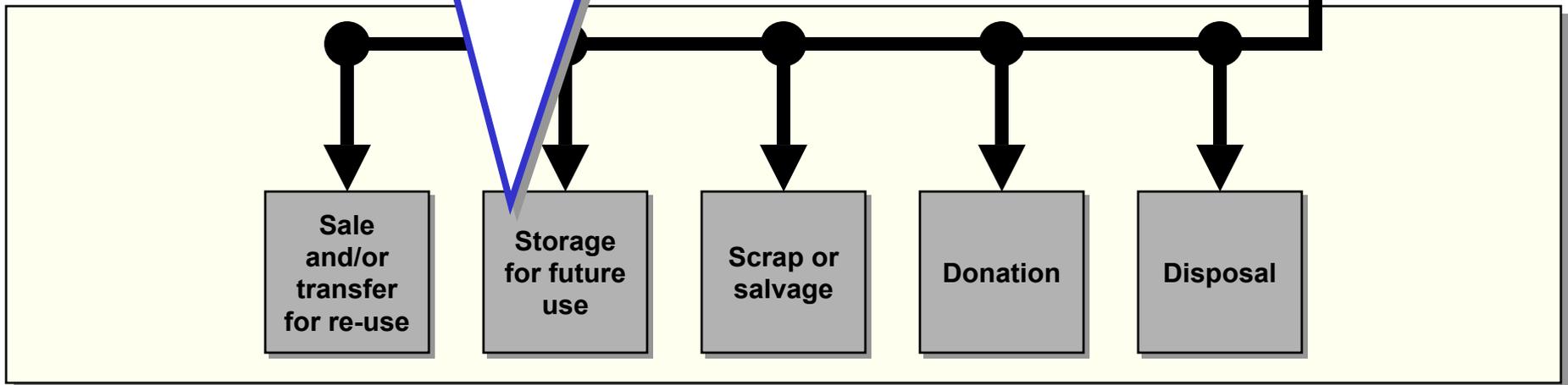
Sale and/or transfer for re-use

Storage for future use

Scrap or salvage

Donation

Disposal





Decommissioning Process Flow - 4

- Clean systems, subsystems, and components as required by scrap or salvage firm receiving the materials, waste, or equipment and to satisfy transport laws and requirements
- **Volume reduction of scrap and waste provides significant dollar savings in the waste minimization process**



Flow - 4

Disposition of all Systems, Sub-Systems, & Components plus Waste Handling

Prepare all wastes for proper shipping & disposal

Execute disposition plan

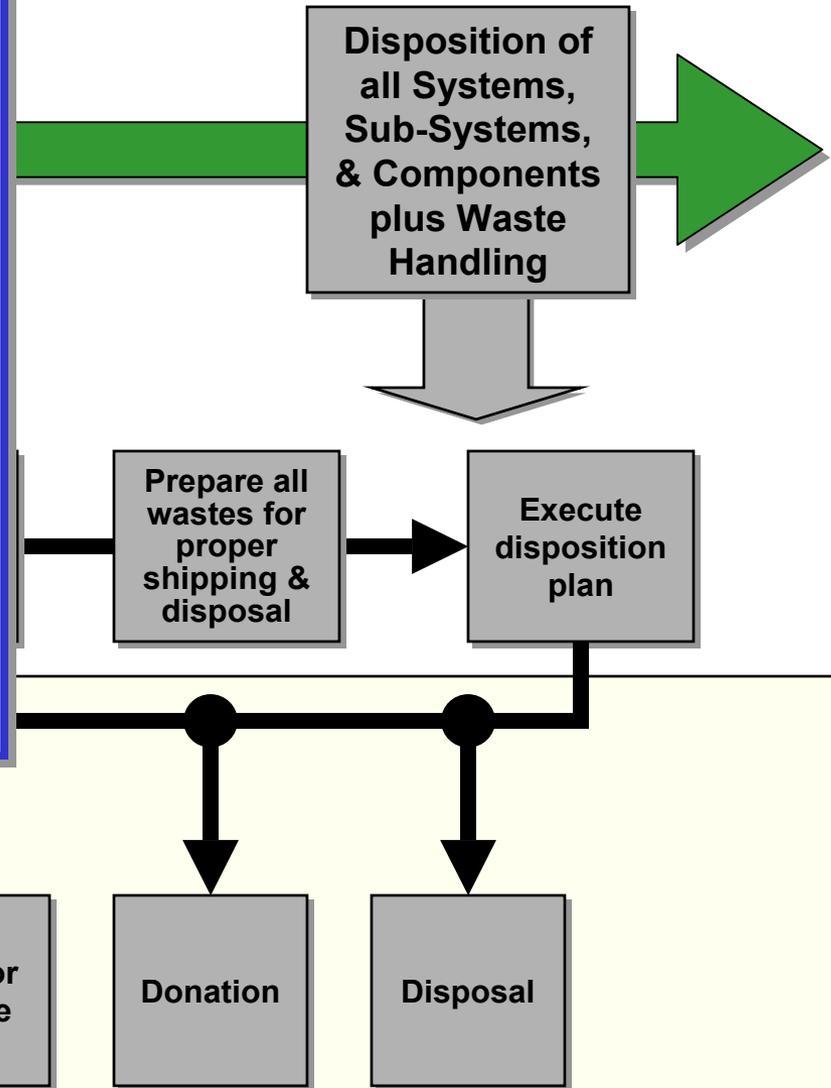
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Disposal





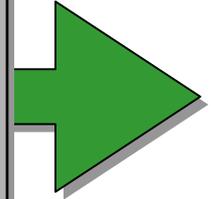
Decommissioning Process Flow - 4

Flow - 4

Make sure receiving organization obtains:

- Copy of final signed Decontamination Declaration Statement
- Verification sampling and analysis data, calculations, summary tables
- List of equipment, systems, subsystems, components, or facility areas that still have chemicals present
- Any tax benefits or other dollar savings obtained from this waste minimization option need to have detailed documentation

Disposition of all Systems, Sub-Systems, & Components plus Waste Handling



Refer to the item disposition matrix

Identify shipper

Prepare all permits for proper shipping & disposal

Execute disposition plan

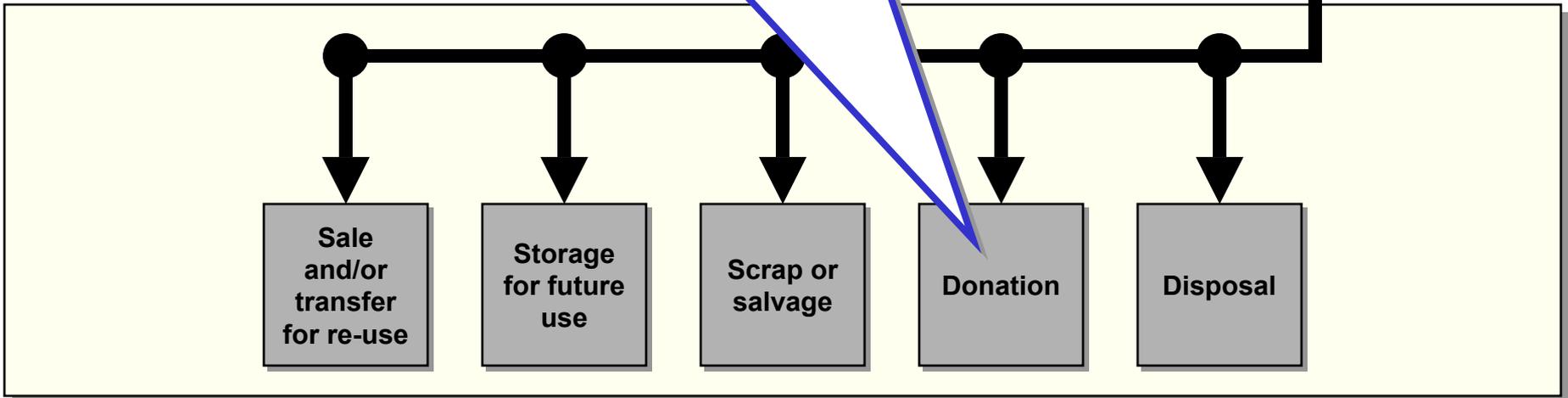
Sale and/or transfer for re-use

Storage for future use

Scrap or salvage

Donation

Disposal



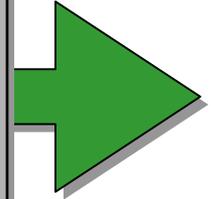


Decommissioning Process Flow - 4

Flow - 4

- Characterize, profile, properly label and package hazardous and non-hazardous waste to permitted and licensed facilities only.
 - Keep and store securely documentation of all waste disposal activities.
- In terms of waste minimization try to execute volume reduction and compression or treatment options before exercising this option if it is not cost prohibitive.**

Disposition of all Systems, Sub-Systems, & Components plus Waste Handling



Refer to the
disposition
matrix

Final
shipper

Prepare all wastes for
proper
shipping &
disposal

Execute
disposition
plan

Sale
and/or
transfer
for re-use

Storage
for future
use

Scrap or
salvage

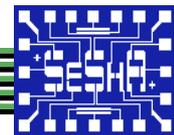
Donation

Disposal



Acknowledgments and References

- ❑ **The industry professionals who have participated in the global series of SEMI Decommissioning Workshops**
- ❑ **The 40 members of the SEMI Decommissioning Task Force**
- ❑ **Bernard Frist, EORM and Robert Barnes, Robert B. Barnes Associates, Inc., *Analyzing Fab Closure Alternatives, ISESH 10th Annual Conference, Noordwijk 2003***





For More Detailed Information

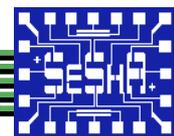
- ❑ **Presentation slides**
- ❑ ***DECON Verification Wipe Sampling Protocol for Facility Closures***
- ❑ **Other DECON facility and equipment decommissioning and decontamination procedures**
- ❑ **Leave your business card, or**

Contact: Bill Belk

bbelk@deconenv.com

510-760-9428 cell

510) 782-8584 fax



Department of Toxic
Substances Control