

Application of Capital Deployment Decision Tools to Remediation

A Process to Select and Evaluate Remedial Alternatives

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Rohm and Haas Company Background

- 100 year Old Global Specialty Materials Company ~\$10 billion annual sales
 - Acrylate & Methacrylate monomers
 - Specialty materials and chemicals for electronics industry
 - Specialty Acrylic Polymers
 - Coatings, Adhesives, Binders
 - Industrial Specialty Materials
 - Ion Exchange Resins, Biocide Preservatives, Sodium Borohydride products, PVS Processing Aids & Impact Modifiers, Industrial Dyes/Markers
 - Morton Salt
- ~120 Manufacturing Sites World Wide
- R&D / Tech. Centers in US, Europe, Asia
- ~100 Managed Environmental Liability Cases - Reserve ~\$170MM
- Significant spending for environmental remediation

What is the Capital Deployment Process (CDP) ?

Why Use it for Remediation?

- Capital Deployment Process is used within Rohm and Haas to manage the development and execution of capital projects from idea conception through start-up and process optimization.



- CDP is a documented assembly of Rohm and Haas and Industry best practices proven to develop and execute the correct capital solutions/projects in a high quality, efficient and cost effective manner. CDP is a "stage gated" process driven by business needs and requirements.

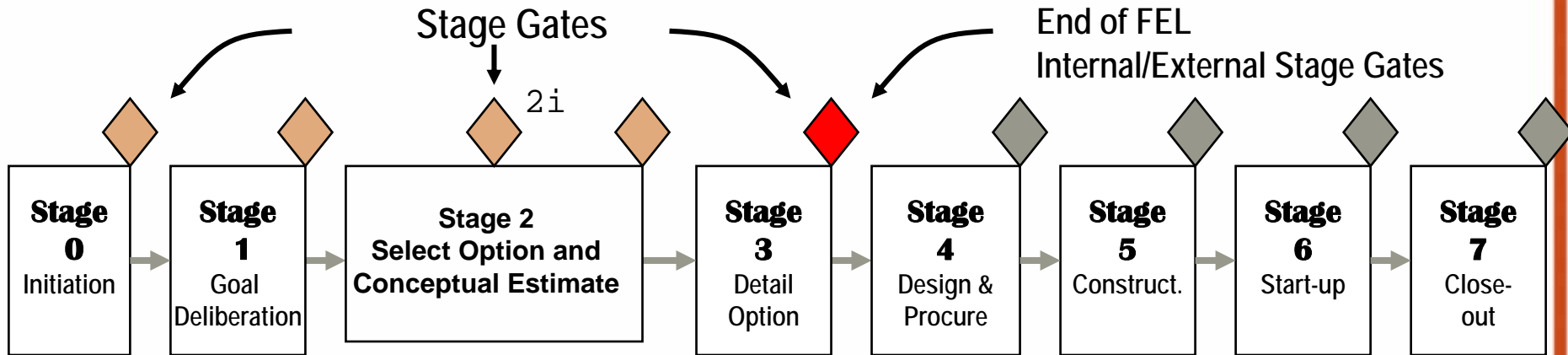
Why Use CDP in Remediation?

- CDP Process & Tools have been successfully implemented on many large & small projects since '96
- Savings from using CDP for Capital Projects >\$200 MM
- Broad Applicability; Plant, Process, Utility Infrastructure, Remediation
- CDP is good business decision making & sound project engineering
- Funding of remediation projects directly reduces capital available to support manufacturing and research.
- CDP Decision Support Tools Applied to Remediation
 - Avoid failed remedies
 - Ensure remedy selected supports company's short and long term goals
 - Avoid over engineered/over designed remedies.



CDP Key Strategies



- Don't build what you don't need
 - Risk Management
 - Monitored Natural Attenuation
- For what you do need, include only what is necessary to meet requirements
 - Goal Deliberation which includes
 - Understanding of Site Conceptual Model
 - Understand Risk Tolerance for the Site
 - Short Term Needs vs. Long Term Goals
 - Site Reuse Options
- Build for as low a cost and as fast as possible –
 - Maximize Return on Remediation Spending

21ST Century CDP Summary Map



Ongoing Activities: VEP's, Performance Measurements, Quality Audits, Alliance Satisfaction Surveys, Progress Reporting, Cost and Schedule Control, Total Value Added

-  = Decision Gate
-  = Progress / Status Gate

-  2i = Agree to proceed on "selected option".
-  2 = Conceptual estimate review and approval - agreement to move into detail the option.

Stage 1 – Project Goal Deliberation

1.1 Project Mission

1.2 Clear & Specific Goals

1.3 Brainstorm Options List

1.4 Resources and Plan for selected option

Key decisions:

- Prioritize Goals (Critical vs. Optional)
- Identify Options (Remedial Alternative)
- Options Evaluation - Selection
- Define resources, funding and schedule to select best option
- Options Evaluation – Selection

Apply Decision Support Tools

- Identify Data Gaps for Options Evaluation - (pilot studies/trials)

Stage 2 Options Selection

2.1 Option Decision

2.2 Basic Process Package

2.3 Conceptual Cost

2.4 EHS Agreement

2.5 Resources & Plan for Detailing the Option

2.6 Permit Application and submittal

2.7 Validate Selected Option – Justification

Output from Stage 2

- Basic engineering package with
- Conceptual estimate to validate the selected option
- Decision to add resources to complete detailed design & generate an AR.

Stage 2 Gate continued

Gate Meeting with Mgmt. Team

Validate selected option:

- Alignment with:
 - Remedial goals and objectives
 - Risk Management/Tolerance
 - Business need

All prior to committing resources to detail the selected option.

Key decisions:

Update and refine goals and objectives

Decide to detail the selected option

Set timing and define estimating requirements/methods to support AR

Stage 3 - Detail the Option

- 3.1 Scope Definition – Fully Defined and Correct
- 3.2 Detailed Execution Plan and Resources
- 3.3 AR Estimate and Approval
- 3.4 Initial Design Packages & Specification Documents
- 3.5 Receive regulatory approvals (as required)

Gate Meeting With Mgmt. Team

Key decisions:

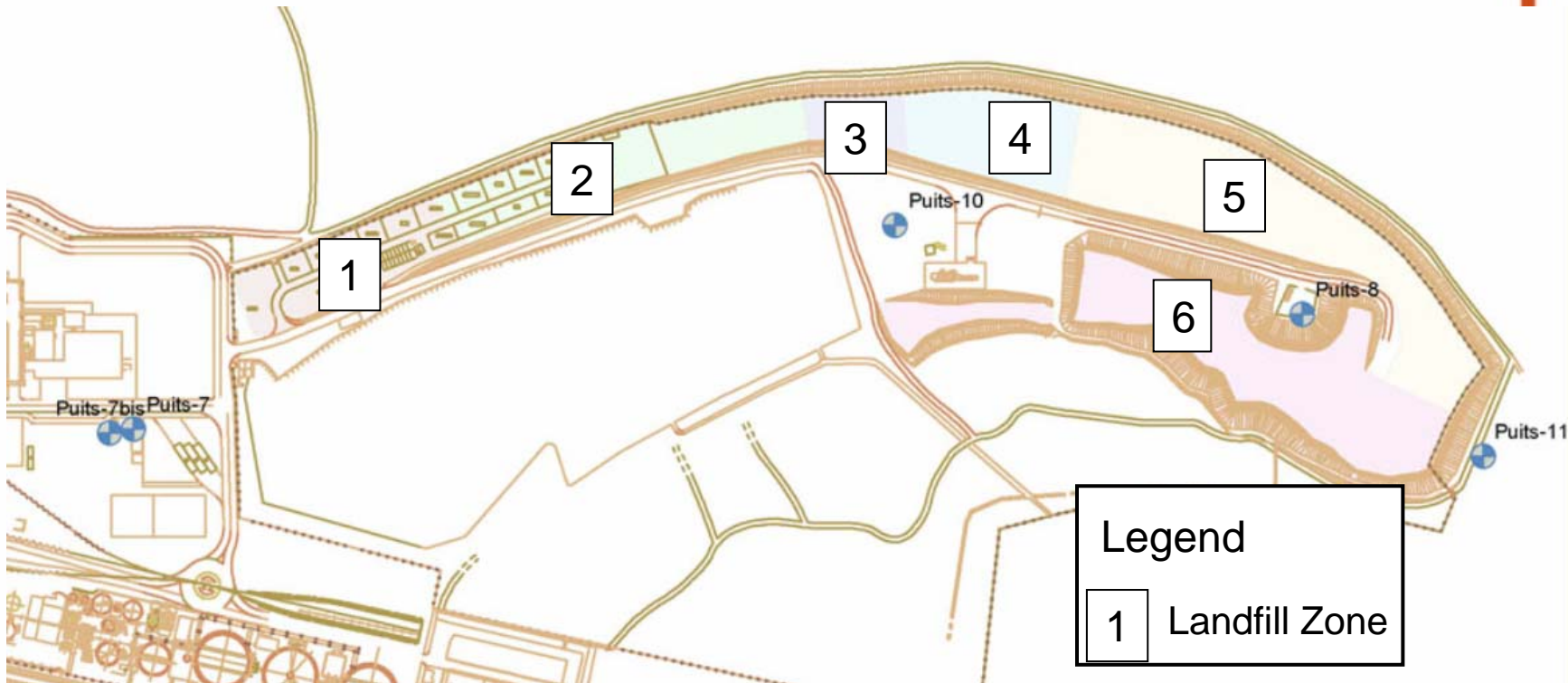
- **Approve capital estimate,**
- **Authorize capital spending**
- **Approve execution plan,**
- **Launch execution stages of CDP**

Remediation Example

– Manufacturing Site in Europe

- Manufactured Mancozeb Type Fungicides for >50 yrs.
- On-site Landfill for Process Wastes; 37 yrs.
- Significant Groundwater Impact
 - Not Affecting Drinking Water Receptors
 - Trans-border plume
 - EU DW Directive for pesticide compounds; 0.10 ug/L
 - World Health Criteria 12 ug/L
 - Plume maximum 800,000 ug/L
- Plume Containment Strategy Implemented in 1985 – upgraded in '04
 - 400 – 600 M3/hr
- Pumping Recognized as not a Permanent nor Sustainable Remedy
- 2005 Management Supports Evaluation of Permanent Remedy

Internal Landfill Background



- Filled west to east in 6 distinct cells, up to 8.5M thick
- Starting in 1976 [end of Zone 1], WWTP started
- Zones 1 and 2 received mostly process and off-spec waste
- Part of Zone 6 underlain by a geomembrane liner

Stage 1 – Project Goal Deliberation

Goal Statement

- Identify cost effective, technically sound, remedial alternative(s) which significantly reduce or eliminate the liability attributable to the Lauterbourg landfill.
- Eliminate or significantly reduce required gw pumping by 2015
- Obtain Regulatory Approval

Option Evaluation Criteria - Musts

- Be technically sound.
- Have manageable impact on the Lauterbourg facility operations.
- Be consistent with Rohm and Haas safety standards, and
- Be cost-effective.

Stage 1 – Options Identification & Evaluation

- Multiple Remedial Technologies Evaluated
 - Removal
 - Stabilization/Solidification
 - Encapsulation
 - Chemical Treatment
 - Biological Treatment
 - Electrical Heating
 - Vitrification
 - Hydraulic Vacuum Extraction
 - Phytoirrigation
- The CDP process was used to screen 14 Alternatives in the categories:
 - Continue Pumping – base case or ‘do nothing’ CDP Option
 - Onsite containment
 - In-situ contaminant destruction
 - Ex-situ contaminant destruction onsite
 - Offsite Disposal

Minimal Alternative Details

- Alternative 1: Continue Pumping ~\$17MM (20yr. Period)
- Alternative 1a: Excavation, liner placement; impermeable cap
 - Estimated Cost - \$9 million
 - Rejected in the Matrix 1 analyses
 - Does Not reduce COC concentrations
 - Untreated waste is future threat gw
 - Long term maintenance & monitoring obligation (Leachate)
 - Not a permanent solution - future liability
 - Subject to permitting & continued regulation
- Demonstrates base cost of minimalistic approach for comparison to alternatives that address long term liability

Preliminary Remedial Alternatives Evaluation

Alternative Cost Ranges

Alternative Type	Cost (\$MM)	Duration (yrs.)
Continue Pumping	17	>20
Encapsulation 3 Alternatives	2-12	1-10
In-Situ Treatment/Stabilization 5 Alternatives	10.4 – 45.3 (30)	2-6
Ex-Situ Treatment 3 Alternatives	42-400 (49)	<5-16
Excavate & Dispose	136	10

Stage 1 – Options Evaluation - Matrix 1

Matrix 1 Evaluation			Alt 1b	Alt 1c	Alt 2a	Alt 2b
CRITERIA		Criticality	Excavate, place a liner, cap, cover	Cap, cover, slurry wall and hydraulic containment	In situ oxidation of silt, sand; cap, cover	In situ Persulfate of silt, sand, with Mn/SO4
1	Obtain full approval by Authorities	Must				
2	Strategy Consistent with Rohm and Haas Safety Standards	Must				
3	Remedial Strategy is technically sound	Must				
3.1	Achieve acceptable long-term liability (substantial reduction)	Must				
3.2	Allow termination of active mangemnt of landfill by 2015	Must				
3.3	Strategy has manageable Impact on Facility Operations	Must				
4	Remedial Strategy is cost effective	Must				
RESULT						

Option Evaluation Against “Must” Criteria

Matrix 1									
	Alt. 1b	Alt. 1c	Alt. 2a	Alt. 2b	Alt. 2c	Alt. 2d	Alt. 3b	Alt. 3c	Alt. 4
	Excavate, place a liner, cap, cover	Cap, cover, slurry wall & hydraulic containment	In situ Oxidn..of silt, sand; cap, cover	In situ oxidation of silt, sand, with persulfate; cap, cover	In situ ChemOx. Silt & Sand plus solidification /stabilization of upper waste	In-situ chemical oxidation waste only, with cap/cover	Excavation bio-treatment, stabilization /solidificaiton	Vadoze Zone Excavation bio-treatment 2a Chem.Ox. silt & sands, stabilization/ solidificaiton	Excavation and off site disposal
BG - PB	Fail	Fail	Fail	Fail	Pass	Fail	Pass	Pass	Fail
ROH - BC	Fail	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Fail
ROH - PTC	Fail	Fail	Fail	Fail	Pass	Fail	Pass	Pass	Fail
CH2M - BC	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail
CH2M - BH	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Fail
CH2M - OM	Fail	Fail	Fail	Pass	Pass	Fail	Pass	Pass	Fail
CH2M - AM	Pass	Fail	Pass	Pass	Pass	Pass	Pass	Pass	Fail
ROH - JLP	Pass	Fail	Fail	Fail	Pass	Fail	Pass	Pass	Fail
RESULT	FAIL	FAIL	FAIL	FAIL	PASS	FAIL	PASS	PASS	FAIL

Option Evaluation – Matrix 2

- Remedial Alternatives Which Fail Matrix 1 are Dropped
- Matrix 2 Compares Alternatives against Optional Criteria
- Optional Criteria Aligned with Primary “Must” Criteria
- Matrix 2 Criteria Have Weighting
 - High, Medium, Low
 - 36 Criteria -
- Result is a Semi-Quantitative Scoring of Remedial Alternatives

1	Obtain full approval by Authorities	Must	
1.1	Meets EA objective reduced ETU source to GW	Optional	High
1.2	Create (+) relationship with Cross Border authorities	Optional	Medium
2	Consistent with ROH Safety Standards	Must	
2.1	No uncontrollable odors during implementation	Optional	High
2.2	No unacceptable noise issue during implementation	Optional	Low
3	Remedial Strategy is technically sound	Must	
3.1	Stop pumping at some future time	Optional	High
3.2	Impact on contractors workshops properly managed	Optional	Low
3.6	Minimizes the storage of hazardous constituents (RM's)	Optional	Low
3.8	Reduces 1,2 DCA in GW	Optional	Medium
	Pass/Fail?		
	Numerical equivalent total		
	Qualitative Rating		

Option Evaluation – Matrix 2

				In situ ChemOx. Silt & Sand plus solidification /stabilization of upper waste		Stabilize waste material (same as 2c) Insitu washing through silt and sand with oxygen saturated water (similar to 2a)		Excavation bio-treatment, stabilization /solidificaiton		Vadoze Zone Excavation bio-treatment 2a Chem.Ox. silt & sands, stabilization/ solidificaiton	
	CRITERIA	Criticality	Ranking Weight	Score	Subtotal	Score	Subtotal	Score	Subtotal	Score	Subtotal
1	Obtain full approval by Authorities	Must		Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
1.1	Meets EA objective reduced ETU source to GW	Optional	High	Medium	5	High	8	High	8	Medium	5
1.2	Create (+) relationship with Cross Border authorities	Optional	Medium	High	5	Medium	5	Medium	5	Medium	5
2	Consistent with ROH Safety Standards	Must		Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
2.1	No uncontrollable odors during implementation	Optional	High	High	8	High	8	Low	2	Medium	5
2.2	No unacceptable noise issue during implementation	Optional	Low	High	5	High	5	Medium	2	Medium	2
3	Remedial Strategy is technically sound	Must		Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass
3.1	Stop pumping at some future time	Optional	High	Medium	5	High	8	Low	2	Medium	5
3.2	Impact on contractors workshops properly managed	Optional	Low	High	5	High	5	Low	2	Medium	2
3.6	Minimizes the storage of hazardous constituents (RM's)	Optional	Low	Low	2	High	5	High	5	Medium	2
3.8	Reduces 1,2 DCA in GW	Optional	Medium	High	5	Low	2	Low	2	Medium	5
	Pass/Fail?				Pass		Pass		Pass		Pass
	Numerical equivalent total										

Option Evaluation – Matrix 2

Results

			Performance of Option							
			Alternative 2c		Alternative 2g		Alternative 3b		Alternative 3c	
			In situ ChemOx. Silt & Sand plus solidification /stabilization of upper waste		Stabilize waste material (same as 2c) Insitu washing through silt and sand with oxygen saturated water (similar to 2a)		Excavation bio-treatment, stabilization /solidificaiton		Vadoze Zone Excavation bio-treatment 2a Chem.Ox. silt & sands, stabilization/ solidificaiton	
CRITERIA	Criticality	Ranking Weight	Score	Subtotal	Score	Subtotal	Score	Subtotal	Score	Subtotal
Pass/Fail?				Pass		Pass		Pass		Pass
Numerical equivalent total				40.0		46.0		28.0		31.0
Qualitative Rating				Medium		High		Low		Low

Users must fill in performance vs. weighting table below. Decide how to score each criteria based on its importance and the performance of the option for that criteria

Subtotal values for criteria scoring

Performance Score

	High	Low	Medium
Weight Low	5	2	2
Weight Medium	5	2	5
Weight High	8	2	5

Low=2
Medium=5
High=8

Stage 2 CDP Alternatives Outcomes

Team Scores

- 3 of 14 Alternatives met all Critical Criteria
- Statistical Analysis of Pooled Data

Alternative Scores	Alt. 2C	Alt. 2G	Alt. 3B	Alt. 3C
Min.	12.21	12.17	13.15	10.82
Median	14.00	14.66	14.13	12.27
Max.	17.00	16.97	15.65	16.00
Avg.	14.28	14.51	14.25	12.78

Stage 2 – Alternatives Evaluation Results

- Alternative 2g: Insitu Oxidation of ETU in sand, silt; ETU destruction by oxidation and inorganic stabilization of the waste above the water table; Cap/Cover
 - Median score 14.66
 - Estimated Cost – \$30 million
 - Retained as the preferred alternative that best meets remediation goals and remediation strategy

Stage 2 – Alternatives Evaluation Results

- Alternative 3b: Excavation and on-site treatment of all the waste and underlying contaminated materials by oxidation assisted bioremediation and stabilization, backfill and cap.
 - Median Score 14.13
 - Estimated Cost - \$49 million (entire landfill)
 - Estimated Cost Zones 1&2 only - \$10.2 million
 - Remedy retained for consideration in selected zones of the site

Managing Risk/Uncertainty

Step 1.4 – Pilot Test & Evaluate

- Predesign investigation of landfill lithology and waste distribution
- Bench scale tests to measure the effectiveness of the proposed remedy
The test goals are to determine:
 - Confirm understanding of Chemistry
 - The extent of ETU destruction by circulation of oxygenated groundwater through impacted waste and soil
 - The optimum reagent quantities required to destroy the organic and stabilize the inorganic in the waste, and
 - The degree of treatment achieved and optimum reagent levels when using ex-situ treatment methods
- Pilot field trials to demonstrate the operating parameters from lab tests; data for scale up in detailed design
- Modifications to the remedy may be proposed for different zones of the landfill to minimize costs.

Oct 05



Aug 06
Feb 08



Oct-Nov 06



2000 02 23

2000 02 23

Imagine the possibilities™

First Round of Testing Fall/Winter 2006

3 Tests:

Oxidation, Aeration and Stabilization

Focus on ETU

In situ and ex-situ

Aeration Tests

Open to air/light

pH variations



Stabilization Tests

Different oxidants, cement and clay ratios

More than 130 cylinders



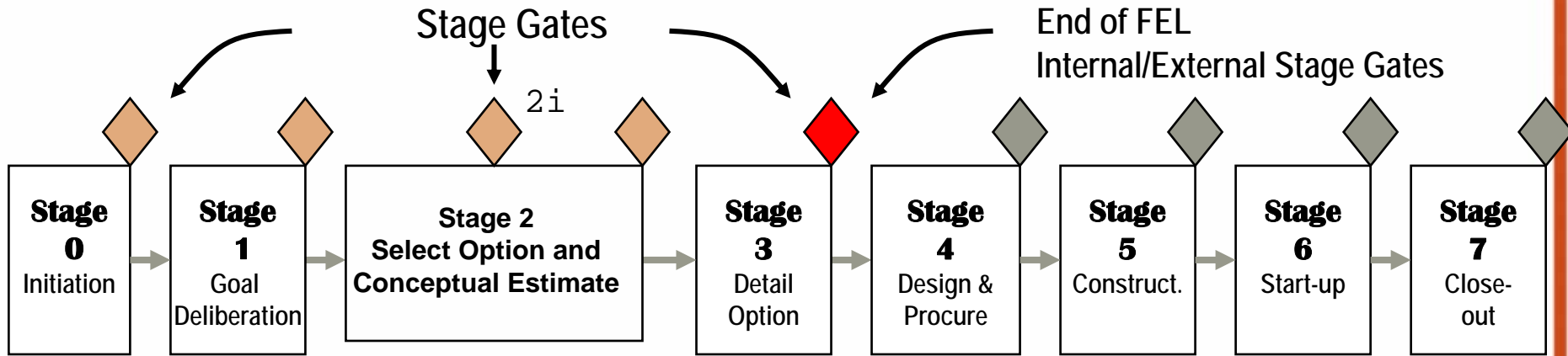
Outcome of Pilot Testing and Pre-design Investigation Activities

- Preferred Alternative – 2G Rejected
 - Detailed Investigation of Silt/Sand Layer Demonstrated that In-Situ Washing for Oxidation would have failed (\$30MM risk)
 - Non-uniform Geology / Preferential Flow Pathways
- Thorough Understanding of Chemistry Controlling Degradation Pathways for Mancozeb in Soil/GW
 - Recognition of >100x source mass in vadose zone
 - Limited Effectiveness of Persulfate
 - Hydrolysis pH>12 highly effective
- New Remedial Alternative
 - Excavation / Soil Washing (Caustic hydrolysis) / Dewatering / Stabilization / Backfill
 - Leverage Existing Wastewater Treatment Facility



Project Status



- ***Gate 3 Management Team Approval of the Following***
 - Approve capital estimate,
 - Authorize capital spending; ~\$15MM (\$10 - \$30MM)
 - Approve execution plan,
 - Launch execution stages of CDP
- **EHS & Logistics Aspects of Process Approved by Host Plant & Business**
- **Held Initial Meeting with Env. Authorities Regarding Permits and Approvals**
- **Moved to Stage 4 – Detailed Design & Procurement**

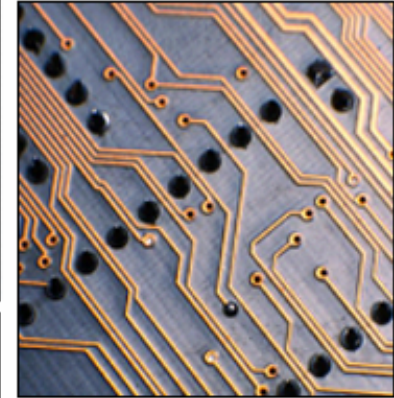
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Thank you.