

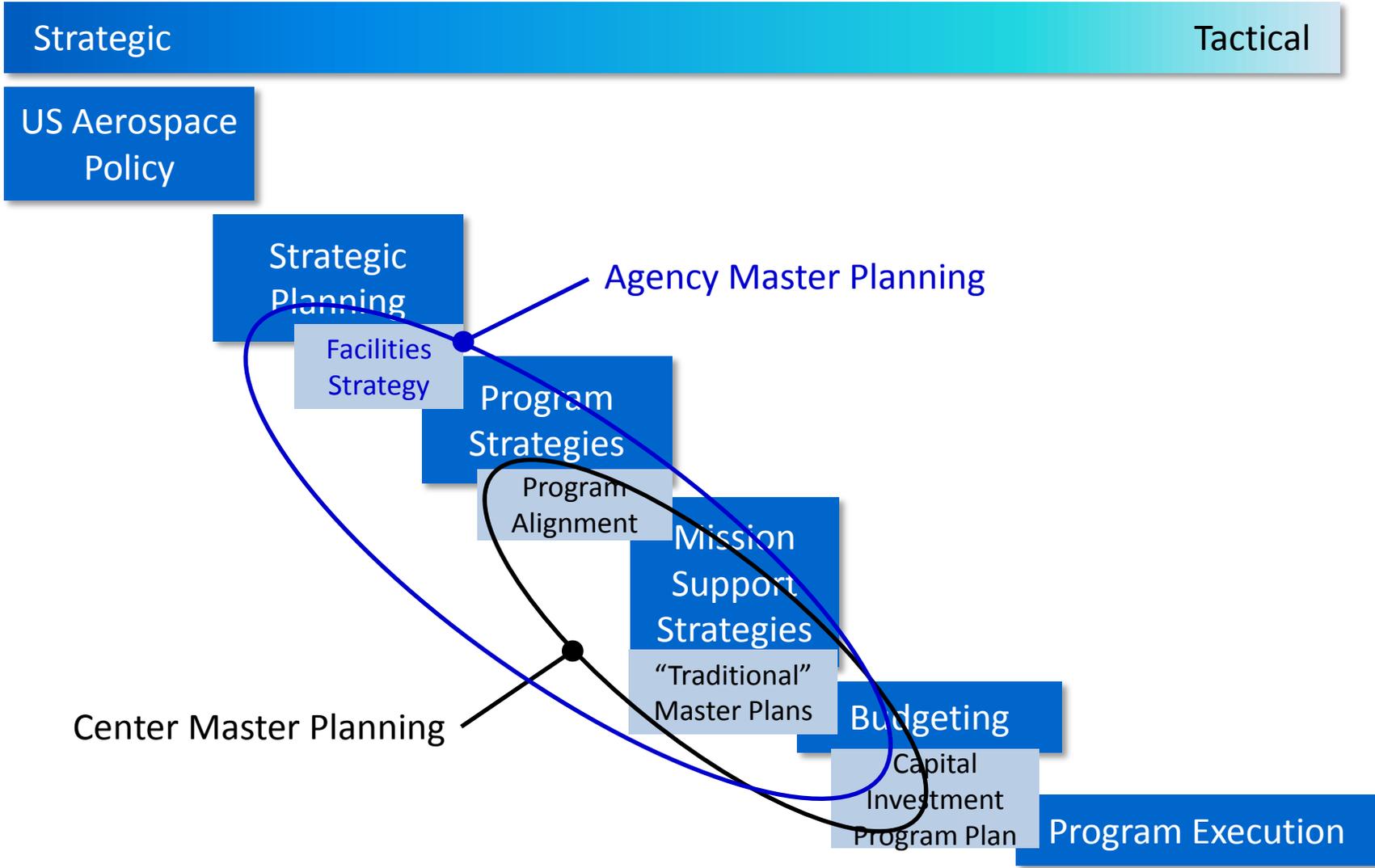
# Integrated, budget-linked **AGENCY MASTER PLANNING**

Kim Toufectis, AICP  
Office of Strategic Infrastructure  
Mission Support Directorate  
NASA Headquarters





# Integrating Facilities with Mission



# Agency Master Planning Products



## At each of 9 Centers and JPL

A Center Master Plan includes



Needs/approach/proposals concept briefing for Agency leadership

20- and 5-year Center capital investment project proposals

ARC MP Summary Metrics				
	Baseline	Program 2019	2020	2021
	End of 2018	Start of 2019	End of 2019	End of 2020
<b>Population on NASA Program</b>				
In-Orbit NASA Facilities	1,000	1,026	1,052	1,078
Non-NASA or NASA Facilities	1,429	1,375	1,342	1,308
In-Orbit NASA Facilities	1,584	1,526	1,497	1,467
Off-Orbit Assets	1	1	1	1
<b>Excluded Assets on NASA Program</b>				
Off-Orbit Assets	4,856,752	4,869,719	4,882,687	4,895,654
Non-NASA or NASA Facilities	482,254	487,270	492,286	497,302
Non-NASA Facilities	223,888	228,904	233,920	238,936
Off-Orbit Assets	1	1	1	1
<b>NASA CIP</b>				
Challenges*	1.03	1.00	1.00	1.00
Adapted*	1.03	1.02	1.02	1.02
<b>Range of Contingency</b>				
High Annual Contingency	84	78	72	66
Annual Change Expendable	0.2	1.8	3.0	3.0
<b>Portfolio Report</b>				
CIP - Value Added Programs**	89	82	75	68

Benchmarks and projected progress v. goals (readiness, size, stewardship, etc.)

## At the Agency level

The Agency Master Plan includes



Illustrative summary of process, proposals, and outcomes with a strategic assessment

20- and 5-year Agency Capital Investment Program Plan (CIPP)

Agency MP Summary Metrics					Including KSC		Change
	Baseline	Program 2019	2020	2021	2019	2020	2019-2021
	End of 2018	Start of 2019	End of 2019	End of 2020	End of 2018	End of 2020	End of 2018
<b>Population on NASA Program</b>							
In-Orbit NASA Facilities	1,000	1,026	1,052	1,078	1,000	1,078	78%
Non-NASA or NASA Facilities	1,429	1,375	1,342	1,308	1,429	1,308	91%
In-Orbit NASA Facilities	1,584	1,526	1,497	1,467	1,584	1,467	92%
Off-Orbit Assets	1	1	1	1	1	1	100%
<b>Excluded Assets on NASA Program</b>							
Off-Orbit Assets	4,856,752	4,869,719	4,882,687	4,895,654	4,856,752	4,895,654	101%
Non-NASA or NASA Facilities	482,254	487,270	492,286	497,302	482,254	497,302	103%
Non-NASA Facilities	223,888	228,904	233,920	238,936	223,888	238,936	107%
Off-Orbit Assets	1	1	1	1	1	1	100%
<b>NASA CIP</b>							
Challenges*	1.03	1.00	1.00	1.00	1.03	1.00	97%
Adapted*	1.03	1.02	1.02	1.02	1.03	1.02	99%
<b>Range of Contingency</b>							
High Annual Contingency	84	78	72	66	84	66	79%
Annual Change Expendable	0.2	1.8	3.0	3.0	0.2	3.0	150%
<b>Portfolio Report</b>							
CIP - Value Added Programs**	89	82	75	68	89	68	76%

Benchmarks and projected progress v. goals (readiness, size, stewardship)



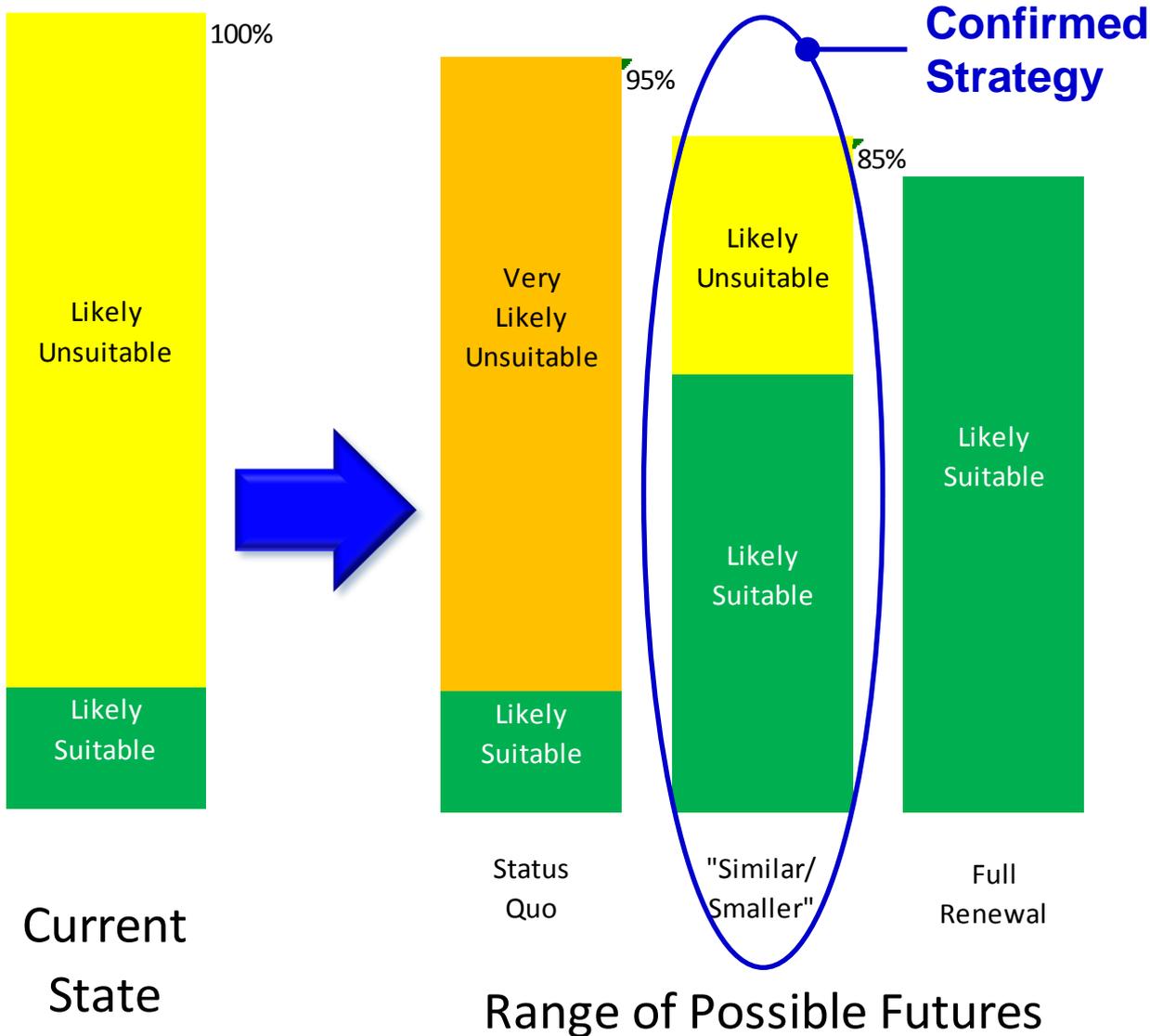
# Key Challenge: Facilities Suitability



## Share of NASA facilities assets under 40 years old



# NASA's Facilities Strategy



***“NASA will renew and modernize its facilities to sustain its capabilities, and to accommodate those capabilities in the most efficient facilities set practical.”***

# From Strategy to a Plan



**2008**

*NASA Administrator*

reviews a model projecting 40-year outcomes of several investment scenarios

Outcomes:

- “Slow and steady” renewal strategy
- Funding pending impacts evaluation

**2009**

*Agency Leadership*

reviews facilities management, resources, strategy, and investments

Outcomes:

- A refined strategy and facilities governance
- Reconfirmed need for renewal funding

**2010**

*NASA Centers* update local master plans;

*Headquarters*

integrates overall implementation plan and investment strategy

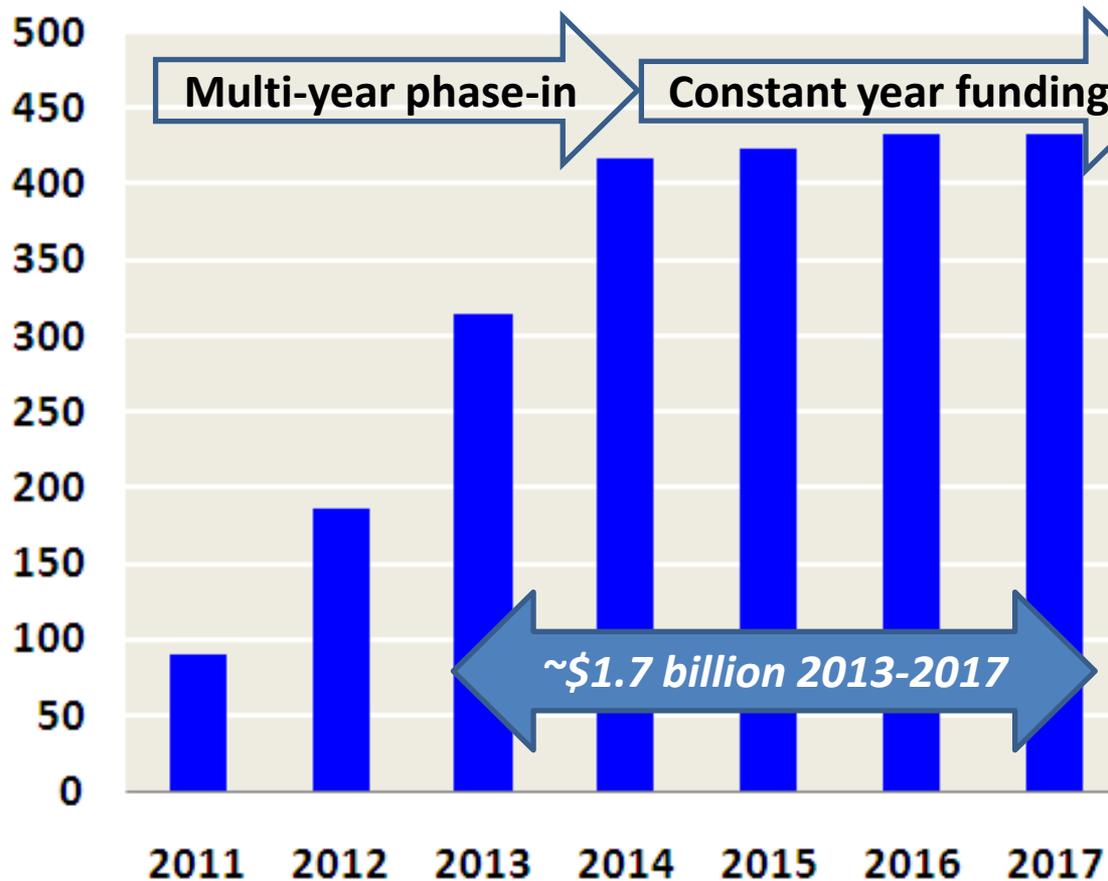
Outcomes:

- Plans more integrated, strategic, consistent
- Strategic renewal plans linked to funding

# Resourcing the Plan

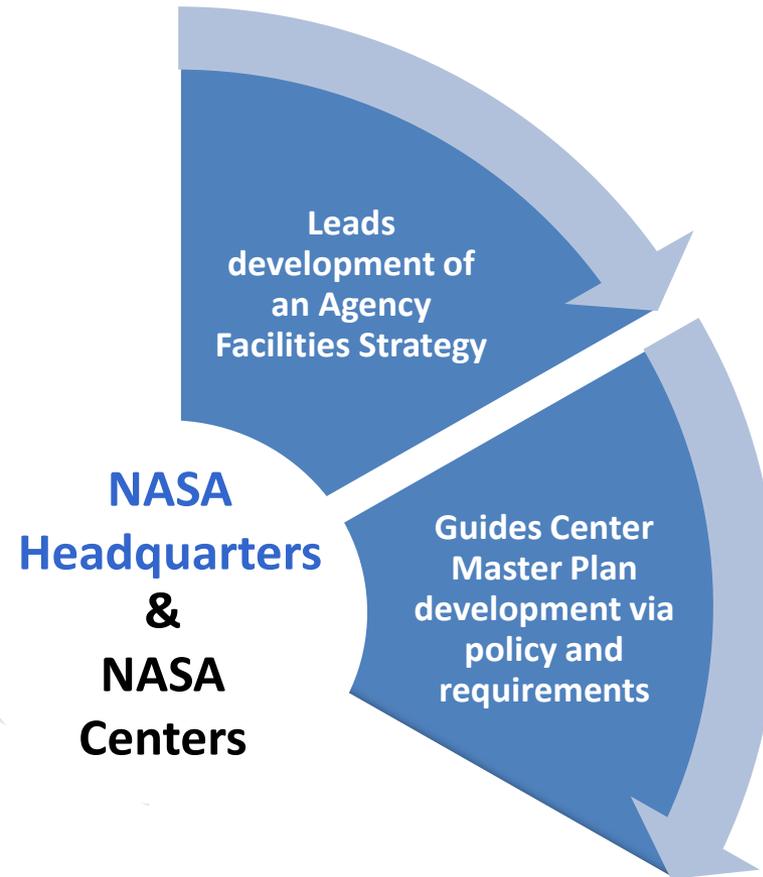


A strategy and timescale are an important step for NASA, but they become a plan as resources let us implement:



- Recapitalization plans roughly triple our prior renewal rate
- Multi-year phase-in to ensure smart execution and soften program consequences

# From Many Plans to One





# Sample: Rigorous Center Plan Development

## LaRC Facility Strategic Planning Roadmap

### Mission / Guidance

<b>NASA Mission</b>	<b>LaRC Core</b>	<b>NASA Guidance</b>
Current Mission...	Aerosciences	<i>Institutional Readiness Project</i>
Early-Stage Innovation	Structures and Materials	"Facilities Program Board"
Game Changing Tech.	Systems Analysis	• Slow-and-Steady, Smaller-Similar
Crosscutting Capability Demonstrations	Charact. of Atmospheres	• Reduce Footprint, reduce CRV
National Policies	Entry, Descent, and Landing	<b>Agency Master Planning</b>
<b>LaRC Mission</b>	<b>LaRC Initiatives</b>	• Great plans, solid process, compellingly conveyed
Exploration: STEP	Create the LaRC of the Future	• ALL asset types
Aeronautics: New projects	• 10 Revolutionary Tech Challenges	• Implementation w/in guidance
Science: New/accelerated	• 9 SOTs, 21 MOTs, 10 IOTs	• Include workforce projections
Shape our Customers/Stakeholders Vision and Make It Real	• Creativity and Innovation Plan	<b>Creativity and Innovation</b>
Drive Innovation to System Solutions	• 21 <sup>st</sup> Century Lab	<b>Other Agency Policies</b>
Operate at the Pace of Innovation	Lab / Facility Integration Team	<b>Fed, State, Local, etc.</b>
Embed Innovation in Our DNA	Large / Small Facility Strategy	National Facilities Study
	Future Facilities Teams	Environmental/Climate Change
	• Structures, Meas. Sys., Aerodynamics, ModSim, Sys. Dev., Fab., Integration	Cultural Resources
	New Town / Special Projects	Energy Reduction
	Maintenance Best Practices	Safety
		External Audits



### Master Plan

- Exploration – direction / needs
- Validation – current assessment
- Hypothesis/Testing – alternatives
- Primary Development Concept
- Development Strategy – Timelines
- S/MA Planning – Risks / Mitigation

**Where We Are Going**

- Repair by Replacement (NT)
- Consolidate within core
- Sustainable
- Efficient
- Flexible
- State of the Art

**How We Get There**

- Right projects at the right time
- Matching projects with funding

**What We Have**

- Processes
- Databases
- Maps
- Utilization



### Projects

**Potential Projects**

↓

**Project Prioritization**

HVAC, Repair, Roofs, ADA, etc.)

Safety, Life Safety, Security, etc.

Lab Consolidation, Demolition

Energy / Environmental

Programs / Center funded

Program-direct, Institutional

Sustainment, Renewal, Transition

↓

**Program Formulation**

**CIPP (20-year plan)**

Recapitalization

New Town Follow-on

New Town (5 phases)

CoF (5-year plan)

Enviro. Comp. and Rest.

Strategic Investment

Center Investment

Maintenance (CM&O, Programs)

Master Project List

### Infrastructure

<b>Wind Tunnels</b>	<b>Laboratories</b>	<b>Simulators/ Aircraft</b>	<b>Other</b>	<b>Horizontal Infrastructure</b>	<b>Real Estate</b>	<b>Office Space</b>
• Subsonic	• Materials	• Aircraft	• LN2 Plant	• Electrical	• Developed	
• Transonic	• Structures	• CMF	• Fab Facilities	• Clean Rooms	• Green space	
• Supersonic	• Measurement	• Laser / Lidar	• Clean Rooms	• Steam	• Wetlands	
• Hypersonic	• Laser / Lidar	• Acoustics	• Digital Library	• Water		
	• Acoustics	• Aerodynamics	• etc.	• Sewer		
	• Hypersonics	• Hypersonics		• Roads		
	• Flight Dyn./Controls	• Flight Dyn./Controls		• HP Air		
	• Crew Sys./Avia. Ops	• Support Cntr		• [ IT ]		
	• Electronics and Avionics Systems					
	• Sys. Dev, Fab, and Integration					
	• Environmental Test					

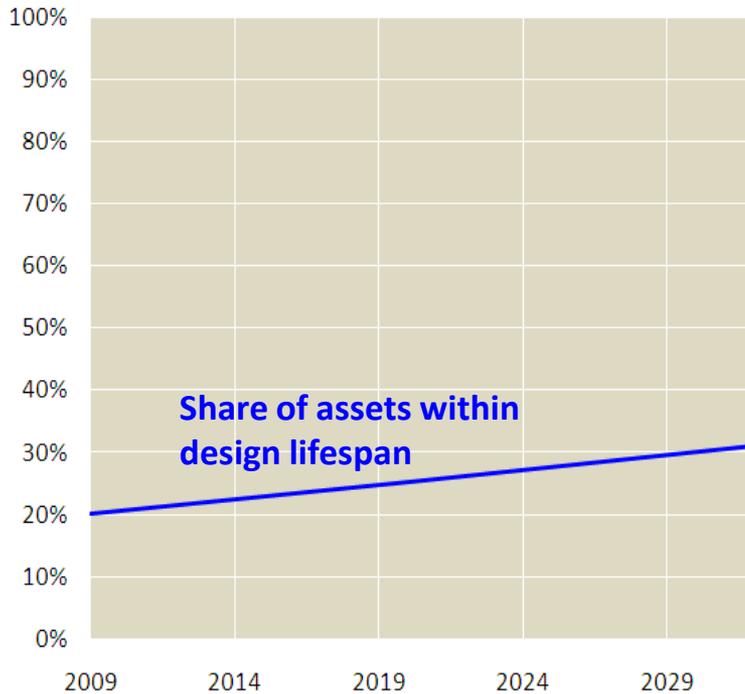
Master Facilities List

Process/interrelationships are illustrative; specifics vary by Center.

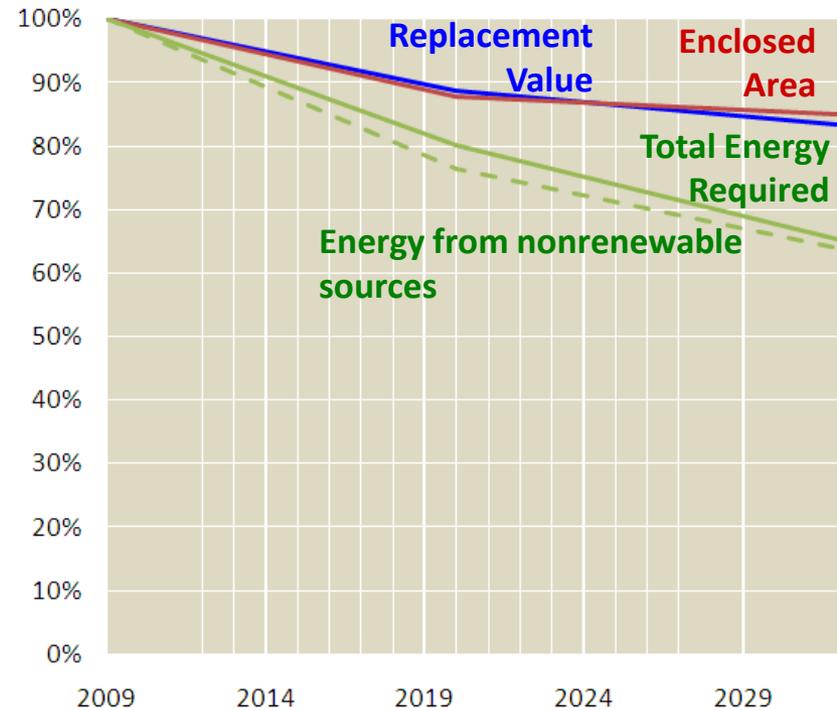
# Results: Managing Outcomes



## Readiness



## Resources



- Preliminary info (KSC excluded after 2020; they're currently revising their plan)
- Consolidation projections adjust for CRV variability at the asset (e.g. building) level
- CRV projections are in current dollars (not indexed to construction cost escalation)

# Results: 5 Year Renewal Planning

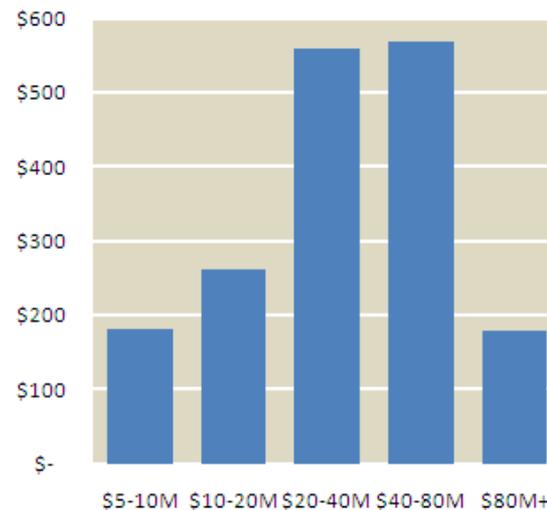


**Scale:** Mostly >\$20M shows a commitment to true renewal of the assets NASA needs

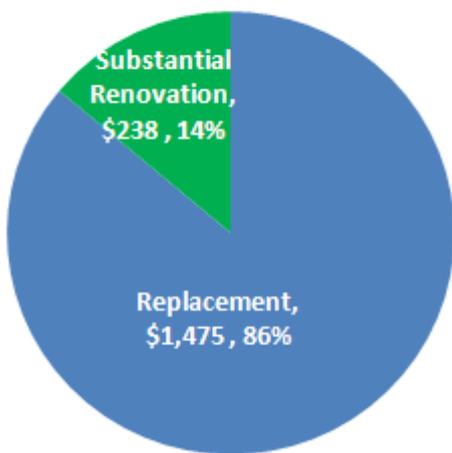
**Approach:** Replacement ensures we have most fully “reset the clock” for degraded assets

**Capability:** Investments are distributed across all required capabilities types

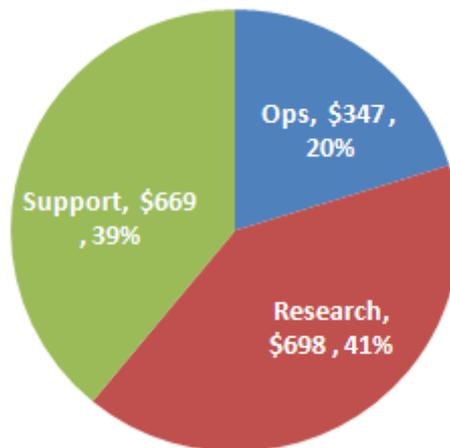
**Asset Type:** Special consideration has been given to ensuring horizontal infrastructure.



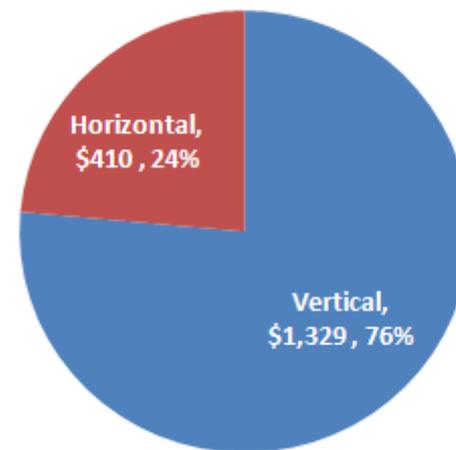
Project Scale (\$M)



Project Approach



Capability Type



Asset Type

# Benefits and Next Steps



## Current benefits

- Using master planning to link projected funding to strategic objectives
- Each Center has a plan to consolidate and renew needed capabilities
- Master plans now guide recapitalization and repair budget planning
- First chance to trend NASA-wide implementation progress
- Comprehensive energy and water conservation planning
- Introduce climate change as a master planning consideration

## Next Steps

- Translate budget consensus about NASA's future into more specific facilities plans
- Seek and assess cross-Center consolidation opportunities for key asset sets
- Grow our expertise at implementing substantial renewal/consolidation
- Update guidance for plan process, products, and metrics



Sustainable  
Facilities:

**Budget  
Reduction  
Impacts**

# Context: How we got started last time



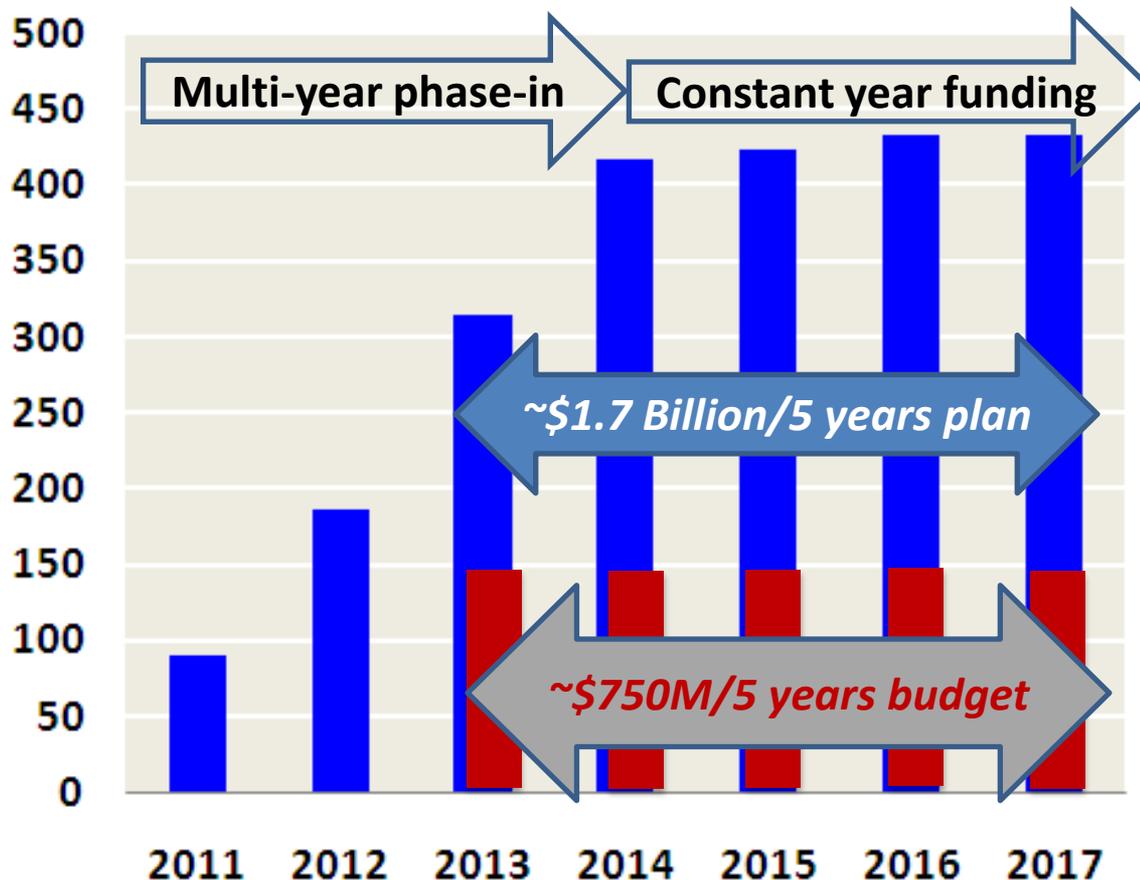
## Share of NASA facilities assets under 40 years old



# Recapitalization Funding



A strategy and timescale are an important step for NASA, but they become a plan as resources are identified to carry it out:



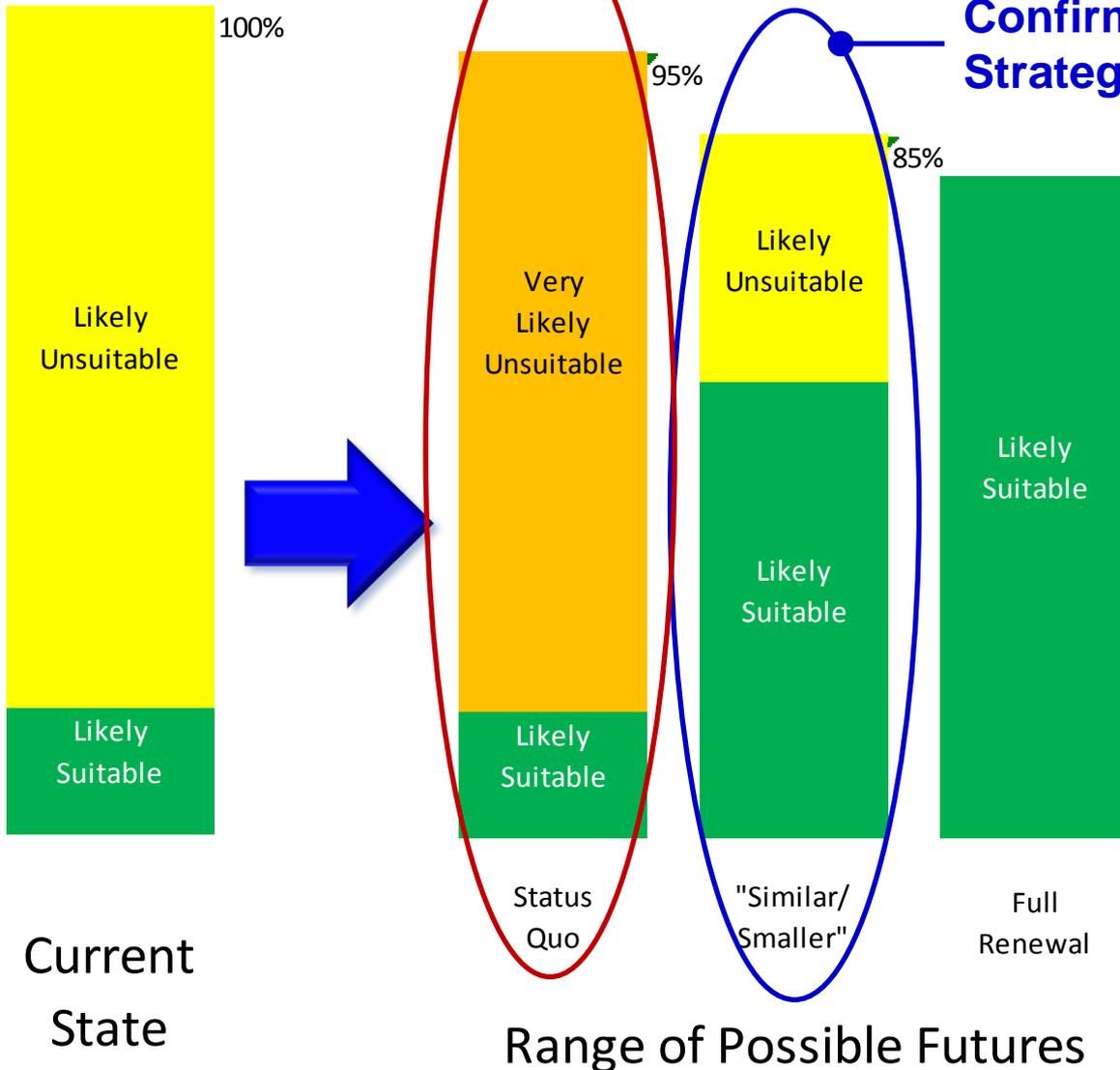
- Recapitalization plans roughly triple our prior renewal rate
- **Current budget (as little as a third of plan) impels new thinking about basic objectives**

# NASA's Facilities Strategy



**Funding Reality: riskier and larger?**

**Confirmed Strategy**

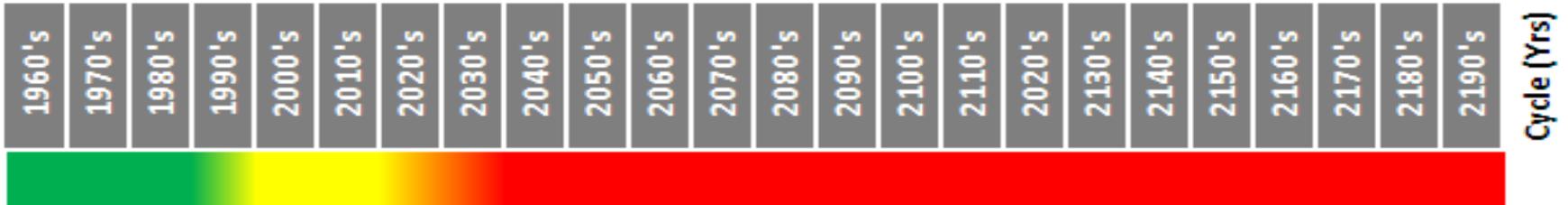


***“NASA will renew and modernize its facilities to sustain its capabilities, and to accommodate those capabilities in the most efficient facilities set practical.”***

# How does funding affect our future?



## Notional Performance



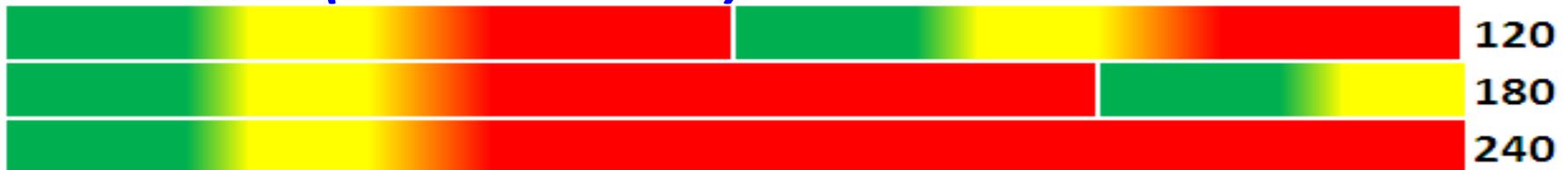
## Full Renewal



## Similar/ Smaller (Agency Facilities Strategy)



## Status Quo (unsustainable)



# What capabilities could we protect?



## A Portrait of NASA's ~4700 Constructed Assets (~\$30B)

20% (~\$6B) Horizontal Infrastructure		20% (~\$6B) Non-technical Buildings		60% (~\$18B) Technical Facilities (Buildings, Test Stands, etc.)					
	(~ 3600 Assets)								(~1100 Assets)
Scales poorly; most would require renewal		(Offsite wherever possible)		Remaining funding could renew ~25% of technical assets (~\$4.5B)					

Each box in this table reflects ~\$300M (1%) of our ~\$30B constructed facilities



## ***Clarifies what \$4.5B tech facilities might include***

- 300 largest tech assets constitute 93% of ~\$18B valuation
- Reserve ~10% of \$4.5B for remaining technical assets
- Used MDI, 2008-09 Facilities Study utilization projection data
- Protect capabilities not practical to reproduce elsewhere
- Preserve a diverse suite of capabilities as possible
- Protect capabilities of critical importance beyond the Agency

## ***Defines a boundary case, not a plan in itself***

- Illustrates one path forward given current funding, practices
- Funding-neutral swaps among capabilities welcome
- Prompts us to reconsider embedded assumptions

# Capabilities to focus on retaining



## ARC

- Tunnels, Arc Jet, HPCC, and research

## GRC/LaRC

- Tunnels and basic aero research (no Plum Brook)

## GSFC/JPL

- Greenbelt and Oak Grove: Research Lab, Instruments, Control Center, and Environmental Testing
- WFF: Island launch, Range
- SCAN: no reductions

## DFRC

- 1 Aircraft Hangar

## JSC

- Astronaut training, Mission Control, Vacuum Chambers
- WSTF

## KSC

- Heavy Launch (stack on pads)

## MSFC

- Station Ops, HLLV design, no MAF

## SSC

- Test stands

***First strawman retains ~\$4.7B of tech assets (nearly 20% over target)***



## ***Assessment: a scenario with many drawbacks***

- Much of current workforce relocates offsite
- Cultural, political, and procedural issues
- This much change brings unforeseen consequences
- We'd try to mitigate impacts as best we could
- Still 80 years to get to even the critical assets retained



## Without a coherent Facilities Strategy...

- Responsibilities outstrip funding; degradation progresses
- Mission impacts are not only inevitable but unpredictable
- Tactical realities (fiscal, political, cultural) define our path

## ...we get the “Death of a Thousand Cuts”...

- NRC Laboratories Study, DM Study project a grim future
- Little opportunity to leverage investments across our goals
  - Rising operations and maintenance costs
  - Climate change adaptation via disaster recovery
  - Limited opportunities to advance environmental stewardship
- Hidden cost to program budgets and schedules to address infrastructure issues in an ad-hoc fashion when status quo risks are unacceptable

# REBOOT: What's coming?



**2008/11?**

*NASA Administrator*

reviews a model projecting 40-year outcomes of several investment scenarios

Outcomes:

- “Slow and steady” renewal strategy
- Funding pending impacts evaluation

**2009/12?**

*Agency Leadership*

reviews facilities management, resources, strategy, and investments

Outcomes:

- A refined strategy and facilities governance
- Reconfirmed need for renewal funding

**2010/13?**

*NASA Centers*

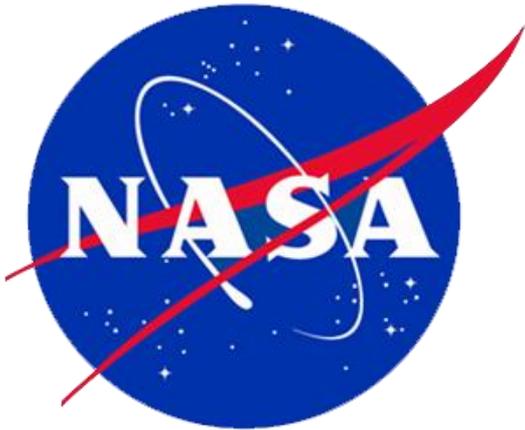
update local master plans;

*Headquarters*

integrates overall implementation plan and investment strategy

Outcomes:

- Plans more integrated, strategic, consistent
- Strategic renewal plans linked to funding



Backup



## *Advocating for facilities investments begins by identifying first causes:*

***Keep assets reliable during their design lifespan***

- Repairs
- Component replacements

***Sustainment Model***

***Address the risks associated with exhausted assets***

- Replace
- Gut Rehab to “reset the clock”

***Renewal Model***

***Cope with forces facilities stewards can't predict***

- Natural disasters
- Significant change in mission/ops

***Design Resilience***

# To avert the Status Quo future...



## ***Possibilities:***

- **Denser:** Consolidate by utilizing facilities more densely
- **Less/site:** Consolidate by shifting activities elsewhere
- **Fewer sites:** Keep tech capabilities by cutting horizontal infrast. further
- **Growth:** Keep tech capabilities by sharing with other paying customers
- **Efficiency:** Keep capabilities by delivering our services for less
  
- **Ostrich Style:** stretch funding across more facilities than it can support

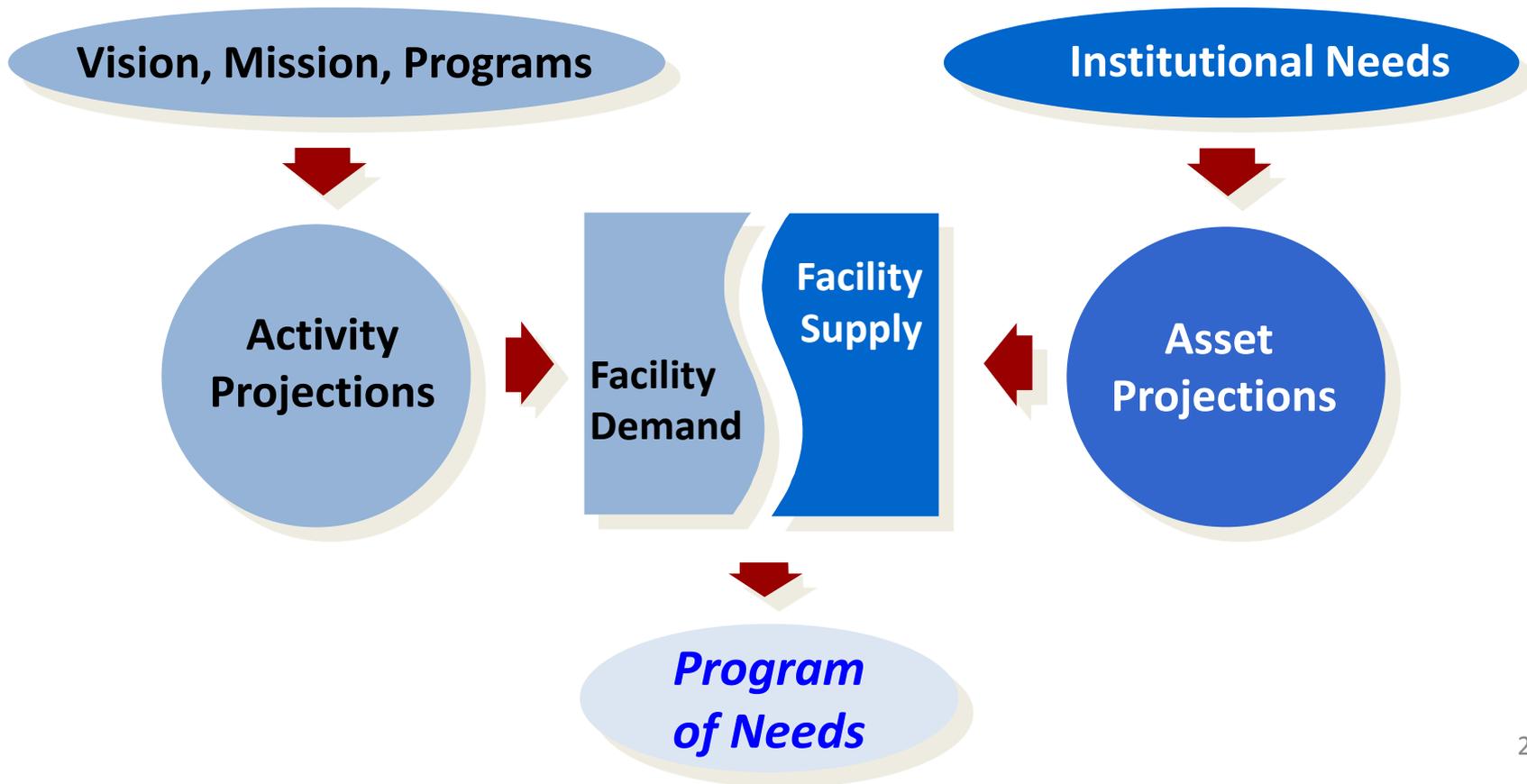
## ***Each would change the way we work***

- **It's time for NASA to reconsider its Agency Facilities Strategy...**
- **None is easy or comfortable**
- **A "strawman" reduction can help begin this important conversation.**

# General Master Planning Challenge



At its most fundamental, master planning is a particularly complex facilities configuration project in which both supply and demand change over time



# Relating Master Plans to other processes



Later



Now

Operational

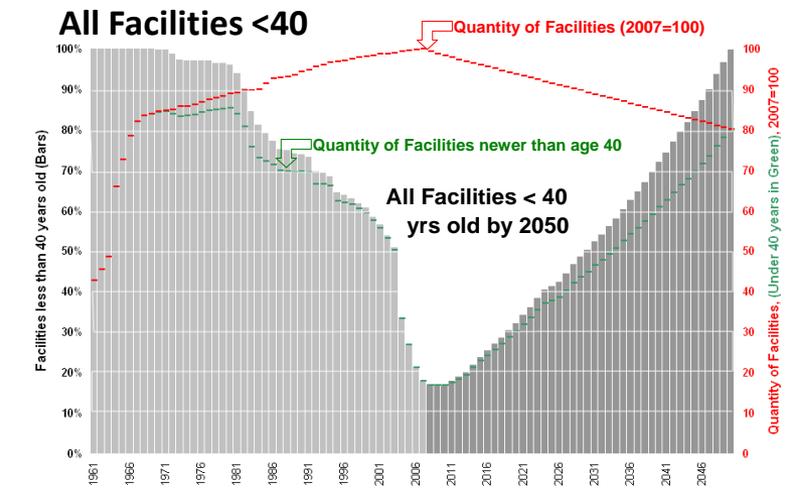
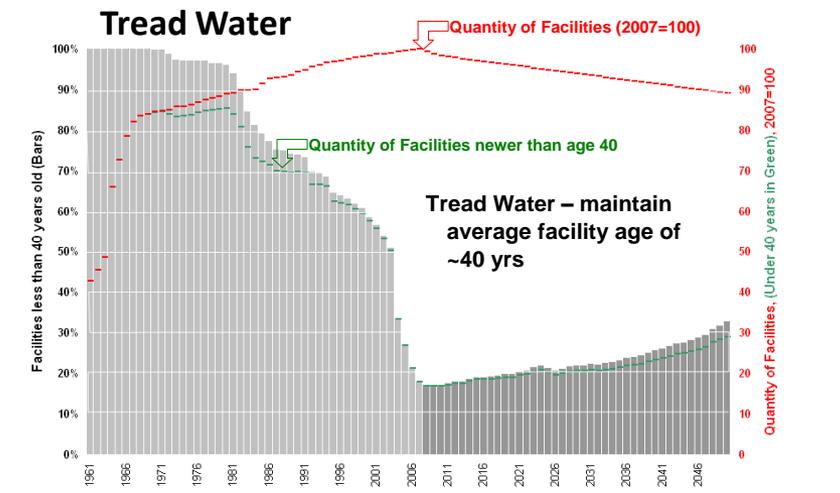
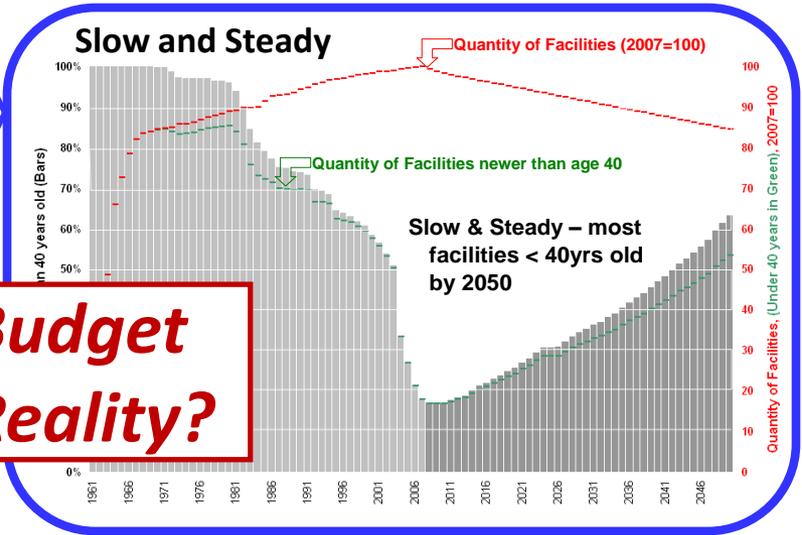
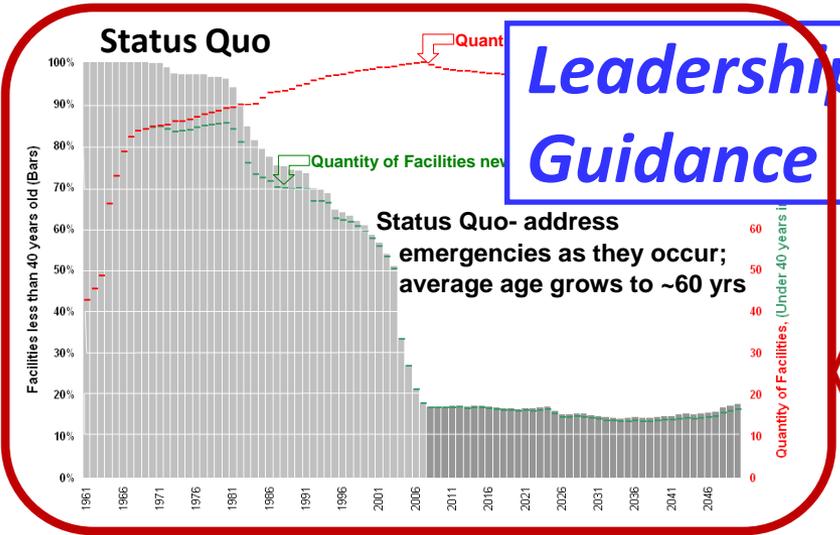
Strategic

# Modeling an Agency Facilities Strategy

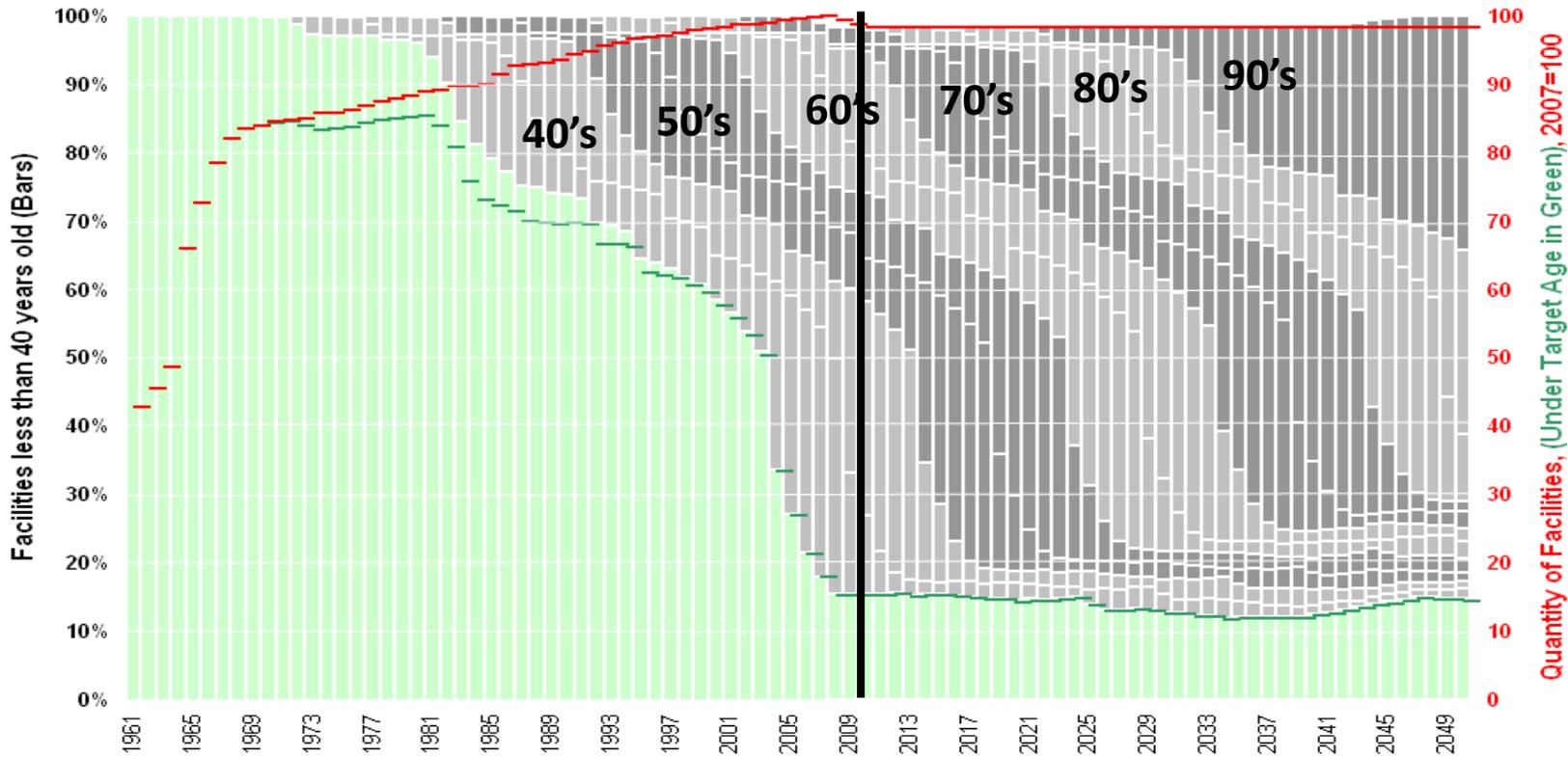


**Leadership  
Guidance**

**Budget  
Reality?**



# What does Status Quo mean long-term?



Facilities Study bottom line: **“Yellow moving to Red”** (PA&E, 2008)

## A much lower renewal rate

- Raises facilities risk to program success
- Limits consolidation
- Means rising facilities operating costs
- Locks in higher energy/water consumption and greenhouse gas emissions



- **Implement gradually over four decades to manage impact**
  - Sustain assets to the point at which renewal is essential
  - Contingent leases would be established for “at-risk” technical and non-technical capabilities
- **Criteria for “Strawman” list of assets to continue to renew**
  - Include assets that reflect the most essential capabilities for NASA’s future and that cannot be accomplished anywhere else (public or private, national or international)
  - Include unique assets essential for the Nation
  - Substantial utilization beyond 2020 (per 2008-2009 Facilities Study)
  - High Mission Dependency Index (MDI) score (60 and up)
- **Results: Screened to \$4.7B (20% too much) for large tech assets**
  - Drastic reductions everywhere
  - No retention at Plum Brook, Michoud, or Wallops Main Base



## **64,000 onsite workforce**

- **18,000 civil servants**
- **46,000 contractors, partners, and tenants**

## **330 mi<sup>2</sup> of land managed (about 25 major parcels)**

- **195 mi<sup>2</sup> (124k acres) owned**
- **135 mi<sup>2</sup> (86k acres) held by agreement (lease, permit, etc.)**
- **Figures exclude 184 mi<sup>2</sup> (118k acres) held by others with use restrictions to buffer Stennis Space Center operations**

## **\$29.1B in Constructed Assets**

- **\$19.4B in ~3050 Buildings enclosing 45M sf**
- **\$ 9.7B in ~1700 Other Structures**



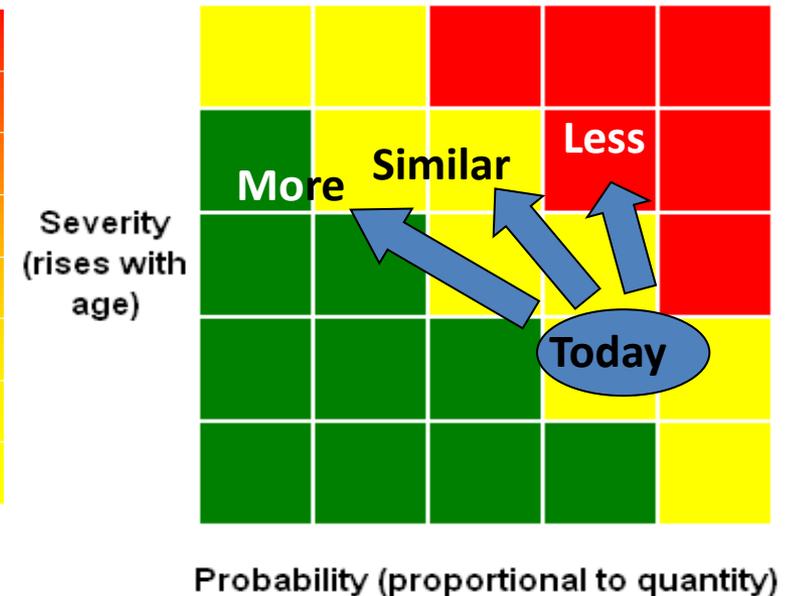
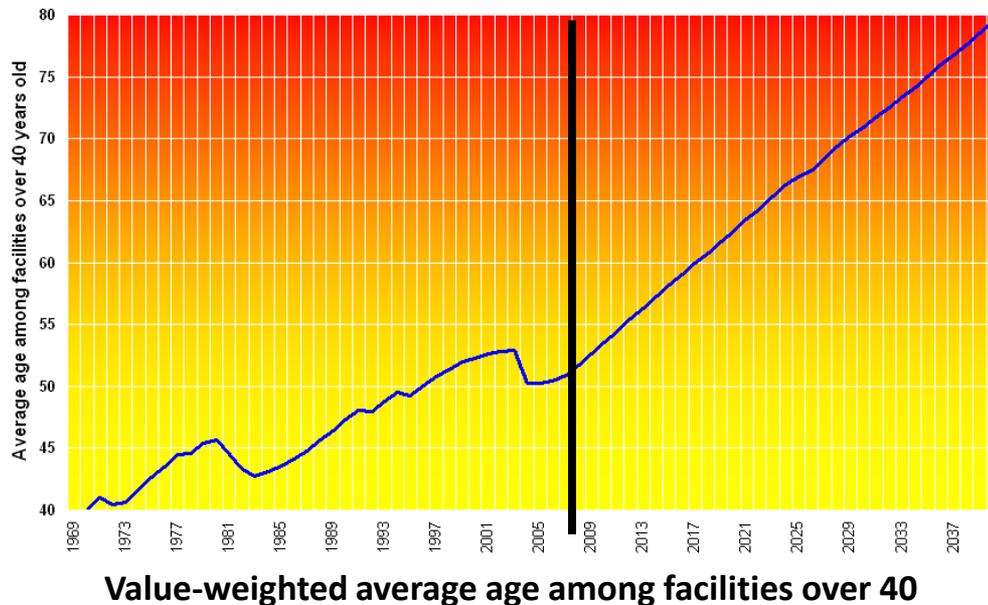
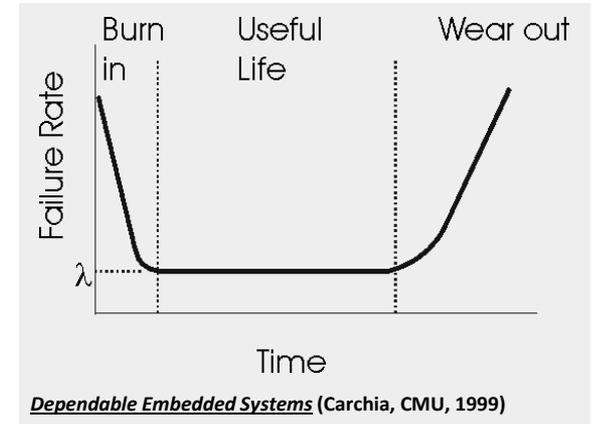
- ***Intent: align facilities development and stewardship with mission requirements over a strategic timeframe***
  - Frame large-scale capabilities and investments over 20 or more years
  - Program/institutional, internal/external issues affecting real property
- **Methodology**
  - Centers develop/adopt per Agency guidance, FERP reviews/concurs
    - Programs and other key stakeholders guide development of a program of needs, oversee plan development for all Center real property assets
    - Annual reconsideration, but a good plan should survive 5+ years
  - Key products include a summary briefing for Agency leadership, a Capital Investment Program Plan, and technical documents documenting development, evaluation, and implementation
  - Agency sets strategic objectives, guides process and content, allocates implementation resources, and manages outcomes
- **Evaluation**
  - Linking to FY10 recap budget is first meaningful resource linkage
  - Quantifying program requirements is a continuing challenge
  - Many opportunities remain to enhance Agency integration

# Notional: Capability Impacts Mission Risk



## Capability drives strategy, cost most

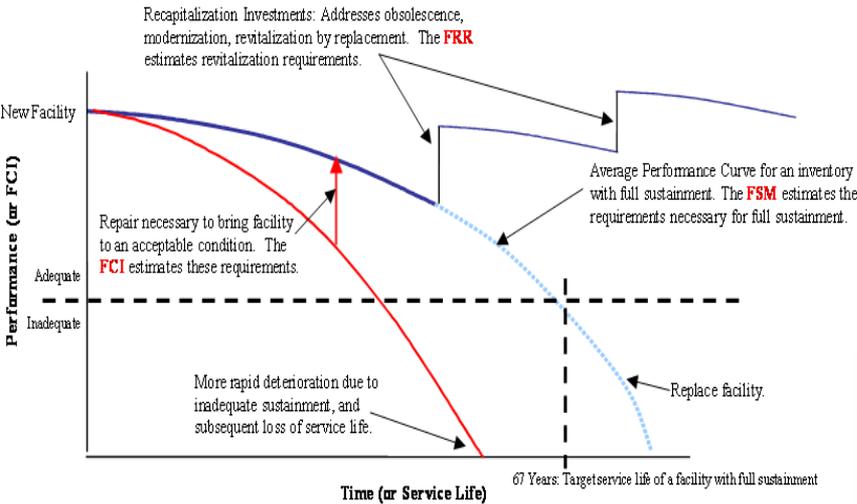
- Assets over 40 pose a risk to mission success
- Risk severity rises as assets age beyond 40
- With 83% >40, even aggressive renewal won't change aging pattern of >40 assets much
- To control risk, control share of >40 assets



# Other Models that assess facilities readiness

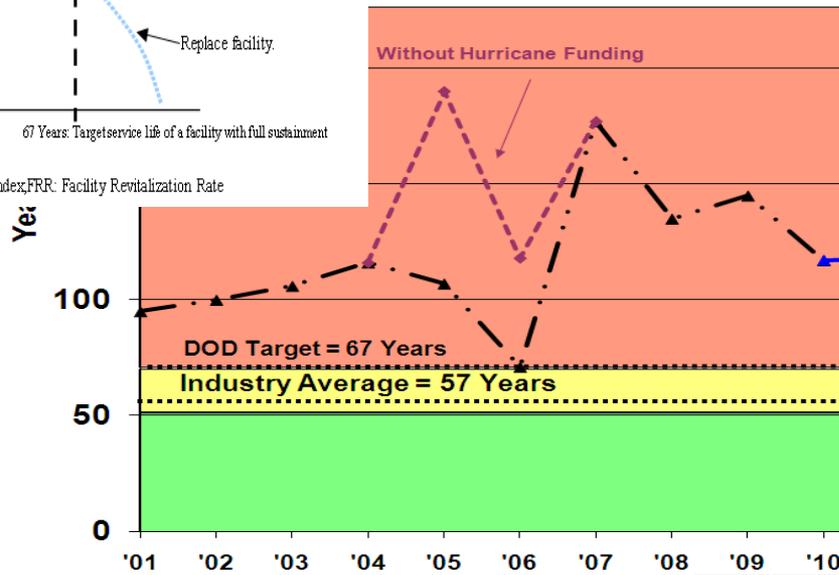


## Condition Modeling



FSM: Facility Sustainment Model; FCI: Facility Condition Index; FRR: Facility Revitalization Rate

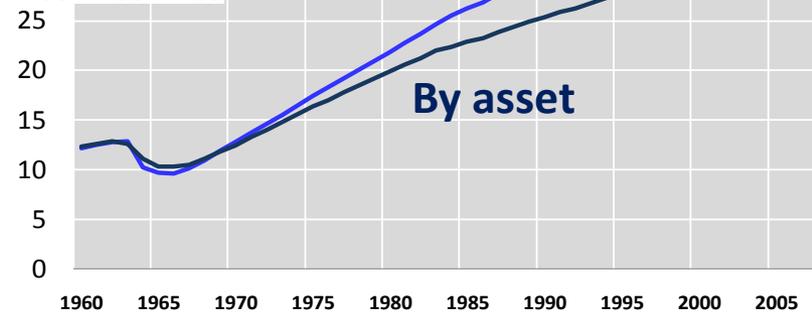
## Revitalization Rate



Value-weighted

By asset

## Average age



# Facilities Study Alternatives and Decision



Capability Infrastructure Size		Less Smaller	Similar Smaller (Slow & Steady)	Similar Similar	More Smaller	More Similar	2009 Budget
		By 2028	Facilities under 40 (likely suitable) %	32%	32%	32%	45%
CRV	\$5.7 B		\$6.8 B	\$7.3 B	\$9.5 B	\$10.2 B	\$3.1 B
Institutional Size Reduction	26%		8%	—	8%	—	—
Costs	Investment Change v. \$100M '09 Budget	+ \$240 M	+ \$285 M	+ \$310 M	+ \$470 M	+ \$505 M	—
	O&M Trend	↓↓	—↓	— —	↑↓	↑—	↑↑
Other Implications	Mission risk: onsite facilities	Fewer facilities Higher risk assoc. w/ nonunique facilities	Fewer over-40 facilities but even older than today	Fewer over-40 facilities but even older than today	Least over-40 facilities (but still older than today)	Least over-40 facilities (but still older than today)	More, older facilities
	Mission risk: shift offsite	New risk, New cost	—	—	—	—	—
	Changes historical onsite/offsite split?	Yes	—	—	—	—	—
	Space utilization culture change?	Significant	Considerable	Moderate	Considerable	Moderate	—
	Investment Challenges	Reduce Footprint	Renew Capability Reduce Footprint	Renew Capability	Enhance Capability Renew Capability Reduce Footprint	Enhance Capability Renew Capability	React to Failures

# FY 2010 Master Planning Updates



## Integrating performance metrics:

- **Renewal, Consolidation, Institutional and Environmental Stewardship Centers each brief Agency leadership by Labor Day**
- Enables an Agency-wide integration of NASA's facilities plans**

	Quarter 1			Quarter 2			Quarter 3			Quarter 4		
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Plan FY10												
Update NPD												
Update NPR												
Centers Review Requirements												
Center Strategy Development												
Centers Develop Briefings												
Agency-level Reviews												
Agency-level Synthesis												

# From Many Plans to One



*If plan development (data gathering, analysis, concept selection, implementation plans) remains mostly at field installations...how do these pieces become one plan?*

**The Agency unites these components by setting objectives, guiding plan content and development, allocating resources, and managing outcomes.**

		Past	Now
Plan Objectives	Local/Center needs	Yes	Yes
	Renewal	None	62% by 2055
	Consolidation	Status Quo	15% by 2055
Plan Content	Implementation Resources	Rarely	Routinely
	Baselines	Staggered	Synchronized
	Duration	Varied	20 Years
Plan Resources	Demolition Program	Some	More
	Recapitalization Program	Minimal	Moderate
	Sustainment Program	Underfunded	Underfunded
Plan Outcomes	Link with Capital Planning	Weak	Direct
	Baselined/Tracked/Trended	No	Under Way
	Center Advocacy for Resources	Adversarial	Collaborative



## *Renewal is defined as “re-setting the clock”*

- Assets ready to perform as if new
- Via substantial rehab or replacement as practical
- Our Agency history hasn’t required this very much until now

## *NASA’s renewal modeling assumes*

- CRV is a reasonable measure of asset value across large populations (we adjust for inconsistency at the asset level when tracking progress)
- It costs \$1 on average to renew \$1 of asset value
- Investment moves with construction inflation thereafter
- Projecting future portfolio ages is speculative; actuals would vary based on renewal/consolidation priorities

## *We’ve only just begun...*

- NASA has identified only partial funding
- Short-term, tactical management strategies don’t change overnight