

National Ecological Observatory Network

Project Overview

T. Beasley/NEON Project Team

NEON

- **NEON: A continental-scale ecological observatory.**
- Set of fundamental science subsystems sampling the drivers/responses of ecological change on spatial scales from microbes to land-masses, proc/store/publish by integrated CI & Ed
- Experimental infrastructure backbone for other experiments in NEON domains... e.g. STREON.

Status

- Design & development phase: May 2008- May 2010:
Project/Observatory design, cost estimates.
- Preliminary Design Review: June 2009
- “Bridge Funding”: Apr 2010 – Apr 2011:
Risk mitigation, prototyping, key facilities, staffing.
- Construction: Oct 2010 – Oct 2015...
- Operations: 2012/13 →

Grand Challenges in Environmental Sciences

1. Biodiversity
2. Biogeochemical cycles
3. Climate change
4. Ecohydrology
5. Infectious disease
6. Invasive species
7. Land use



NRC (National Research Council). 2001. Grand Challenges in Environmental Sciences. Washington DC: National Academies Press.

NRC (National Research Council). 2003. NEON: Addressing the Nation's Environmental Challenges. Washington DC: National Academies Press.

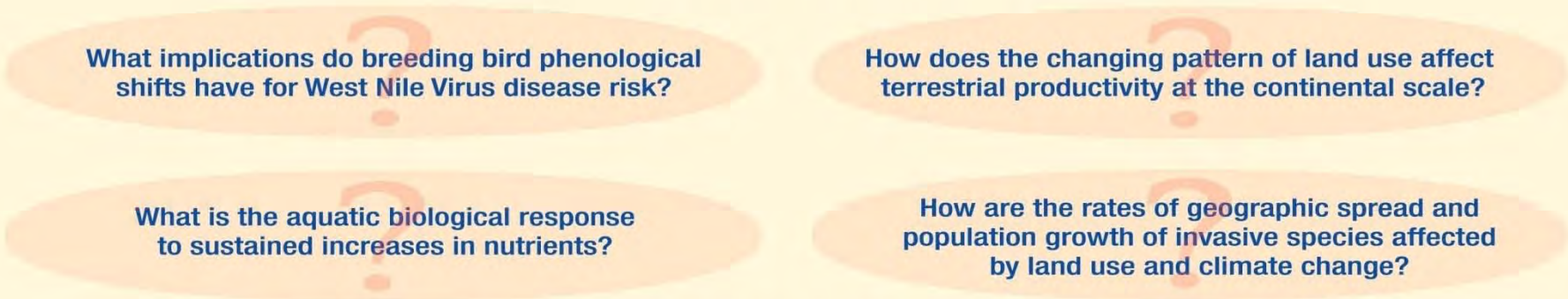
NRC (National Research Council). 2001. Grand Challenges in Environmental Sciences. Washington DC: National Academies Press.

NRC (National Research Council). 2003. NEON: Addressing the Nation's Environmental Challenges. Washington DC: National Academies Press.

GRAND CHALLENGES



Lead to focused questions that NEON can address on continental scales...



That require specific data products to answer the questions...



And NEON's infrastructure supports science packages that provide the measurements required to produce the data products



Level 1 Data Product Deliverables

(Total = 584)

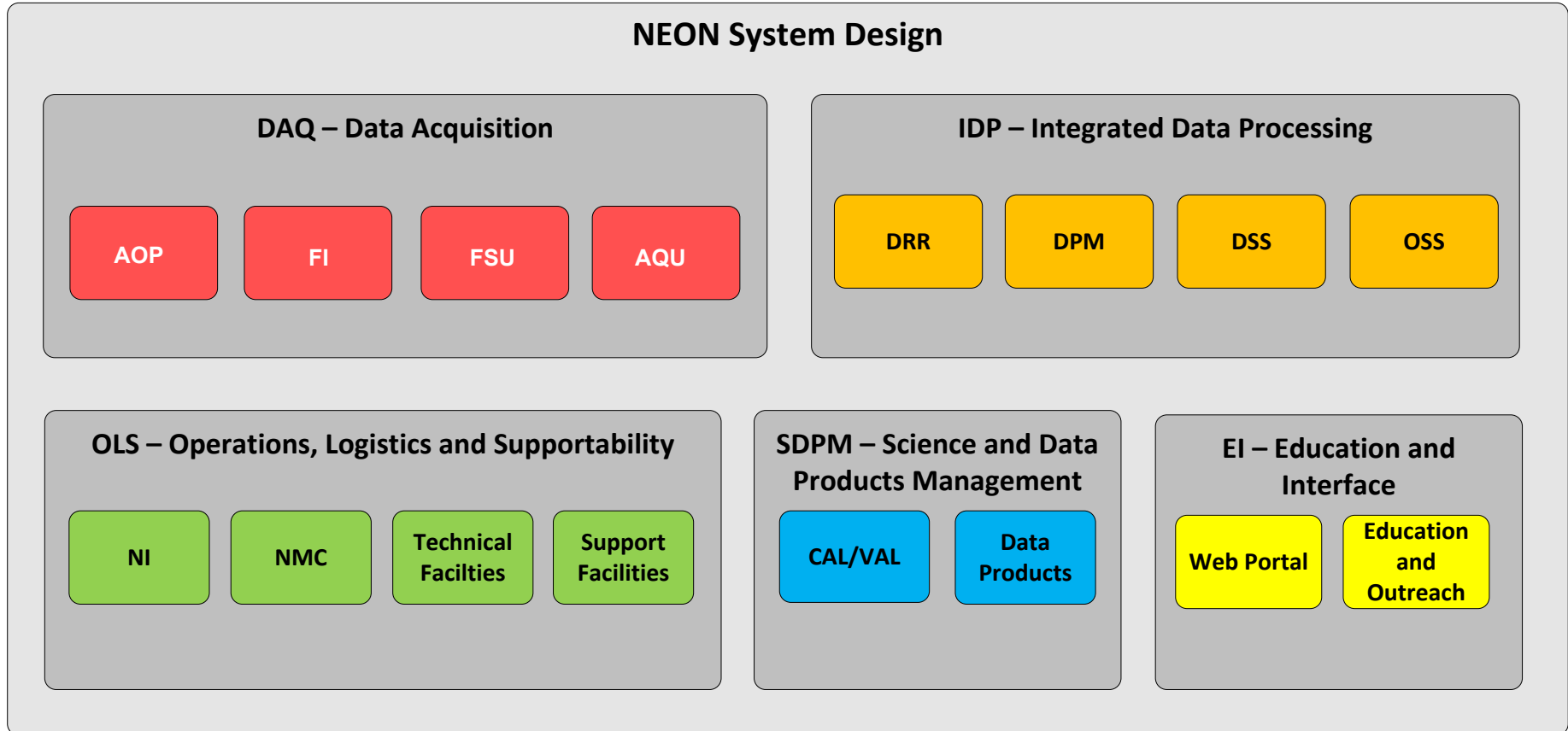
Science Sub-System	Level 1 Products	Examples
FSU	269	Species ID, number of individuals, Hantavirus presence, tree diameter, leaf N concentration
Aquatic/STREON	164	Algal cell count, macroinvertebrate biovolume, stream discharge
FIU	104	Temperature, humidity, PAR
AOP	4	Spectral reflectance, vertical waveform
LUAP (Level 3)	43	Topography, satellite spectral reflectance, human population density
TOTAL	584	

Level 4 Data Product Deliverables

(Total = 117)

Suite	Level 4 Products	Examples
Bioclimate	18	Climate forcings, LAI, fPAR
Biodiversity	31	Abundance, diversity, phenology, demography
Biogeochemistry	29	Ecosystem-atmosphere exchange, nutrient stocks and fluxes
Ecohydrology	10	Soil moisture, water-balance, stream discharge
Infectious Disease	7	Disease prevalence (WNV, Lyme, dengue)
Land Use Change	22	Environmental properties, land cover, land use

NEON System Design



Details in Obs Design talk.....

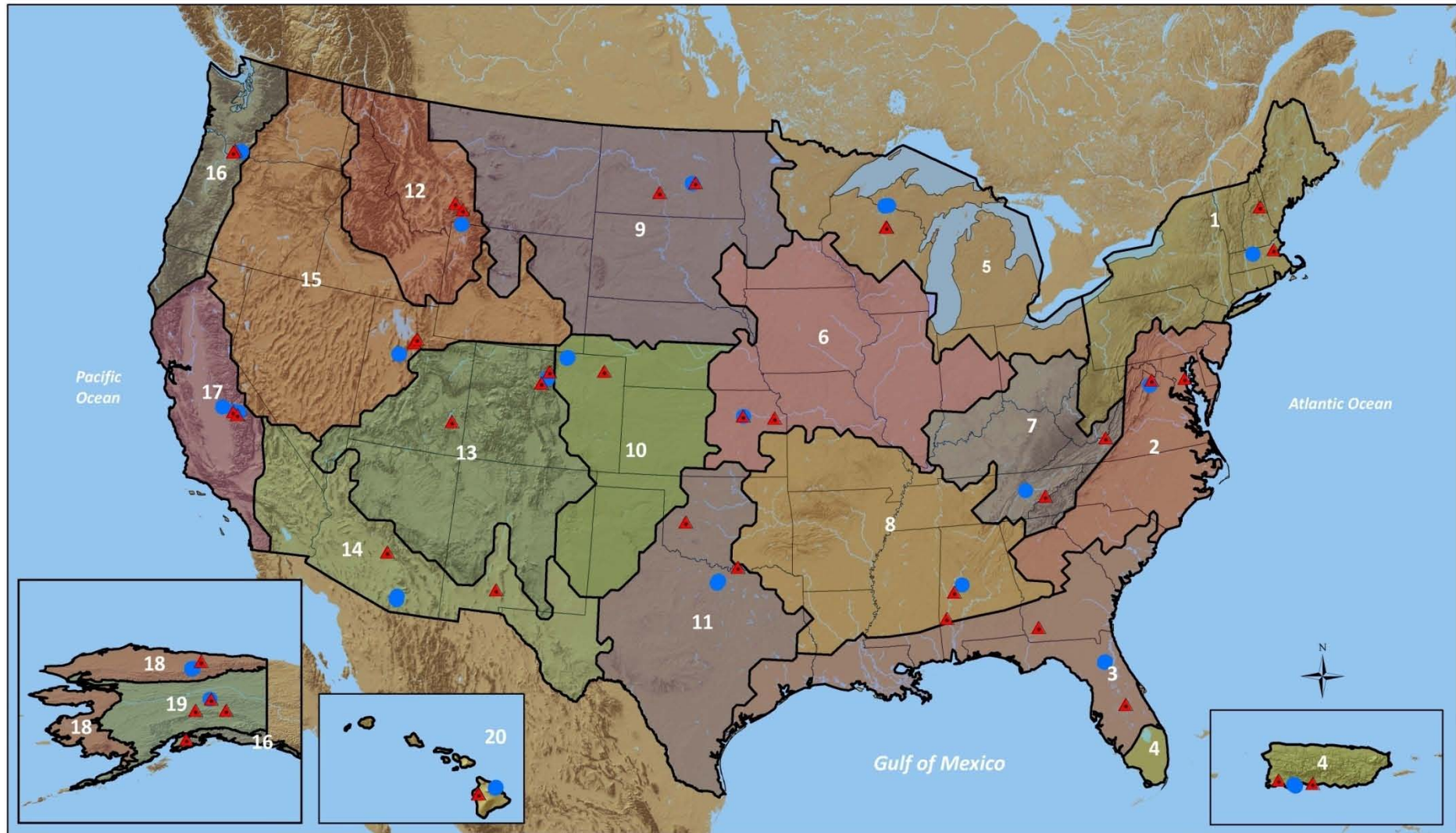
NEON Science Subsystems

FSU:	Fundamental Sentinel Unit	Human Observers/Samplers
FIU:	Fundamental Instrument Unit	Automated Instrumentation
AOP:	Airborne Observation Platform	Aircraft Remote Sensing
LUAP:	Land Use Analysis Package	Satellite Remote Sensing +
A-S	Aquatic/STREON	Instr. + field sampling

+ Education mission: Prepare society/scientific community to use NEON data, information, forecasts...

NEON Deployment

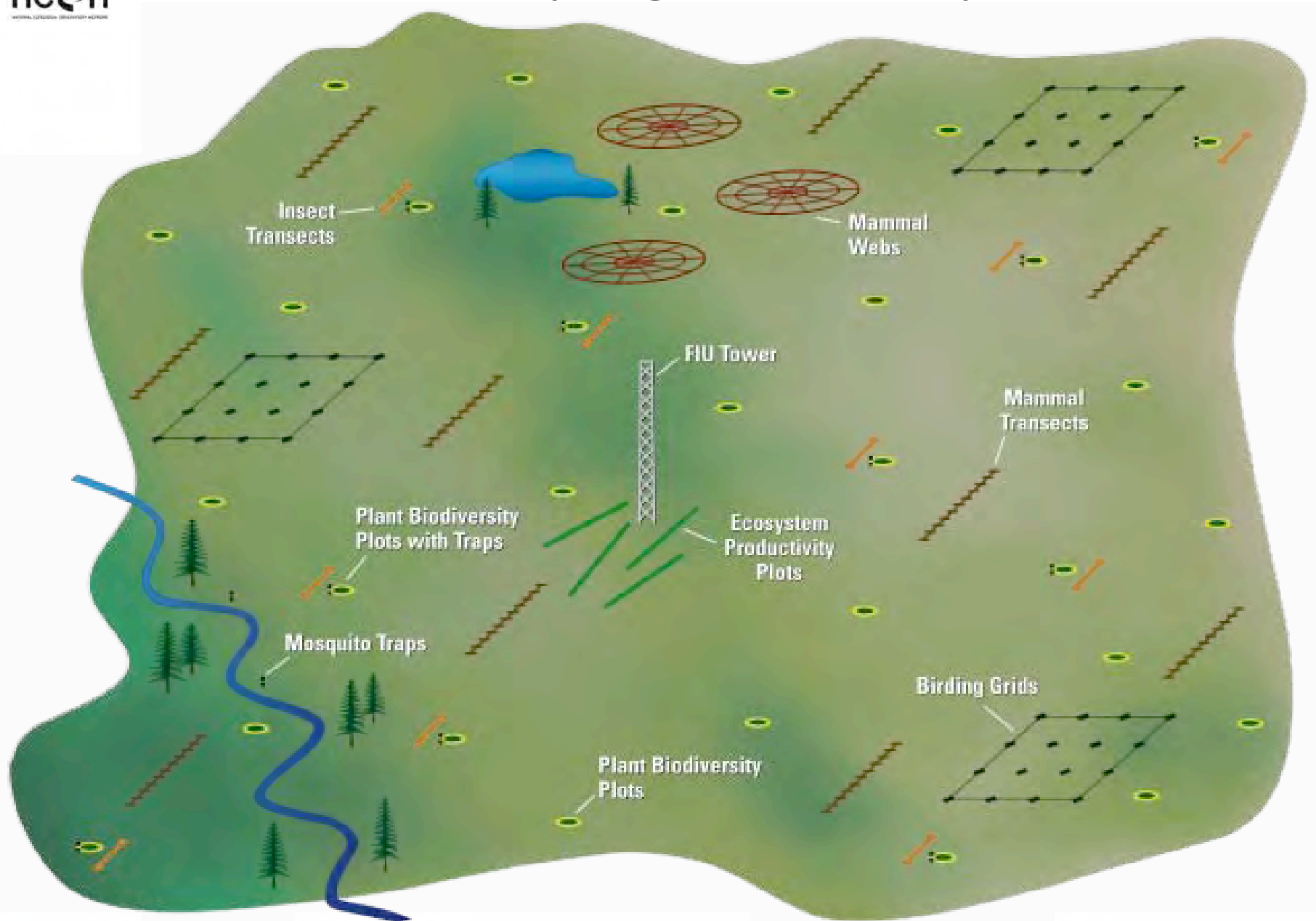
- Headquarters (incl. CI, labs, facilities) - CO
- 20 Domains
 - 20 Core sites (wildland)
 - 40 Relocatable sites (~land-use sites)
(62 distinct sites)
- 10 Mobile laboratories (AK, HI, CONUS+PR)
- 3 Airborne Observation Platforms
- Cyberinfrastructure/Data Center/LUAP



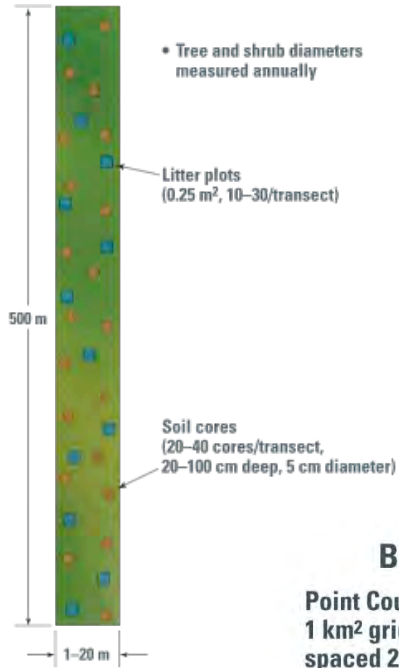
NEON Domains

- | | | | | |
|------------------------|-----------------------------------|---------------------|--------------------------------------|----------------------|
| 1 Northeast | 5 Great Lakes | 9 Northern Plains | 13 Southern Rockies/Colorado Plateau | 17 Pacific Southwest |
| 2 Mid Atlantic | 6 Prairie Peninsula | 10 Central Plains | 14 Desert Southwest | 18 Tundra |
| 3 Southeast | 7 Appalachians/Cumberland Plateau | 11 Southern Plains | 15 Great Basin | 19 Taiga |
| 4 Atlantic Neotropical | 8 Ozarks Complex | 12 Northern Rockies | 16 Pacific Northwest | 20 Pacific Tropical |

NEON – sampling drivers/responses



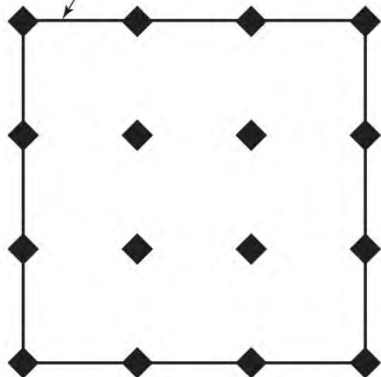
Ecosystem Productivity Plot



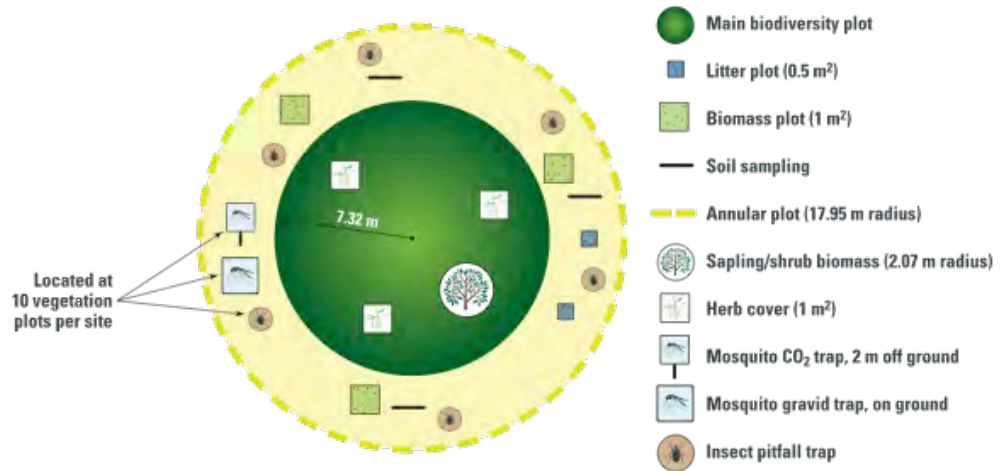
Birding Grid

Point Count observations of birds in 1 km² grid with observing stations spaced 250 m apart

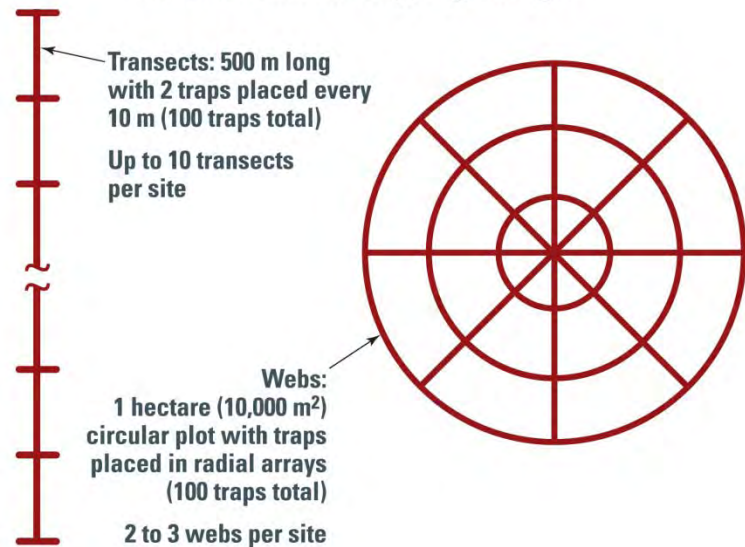
3–10 birding grids per site

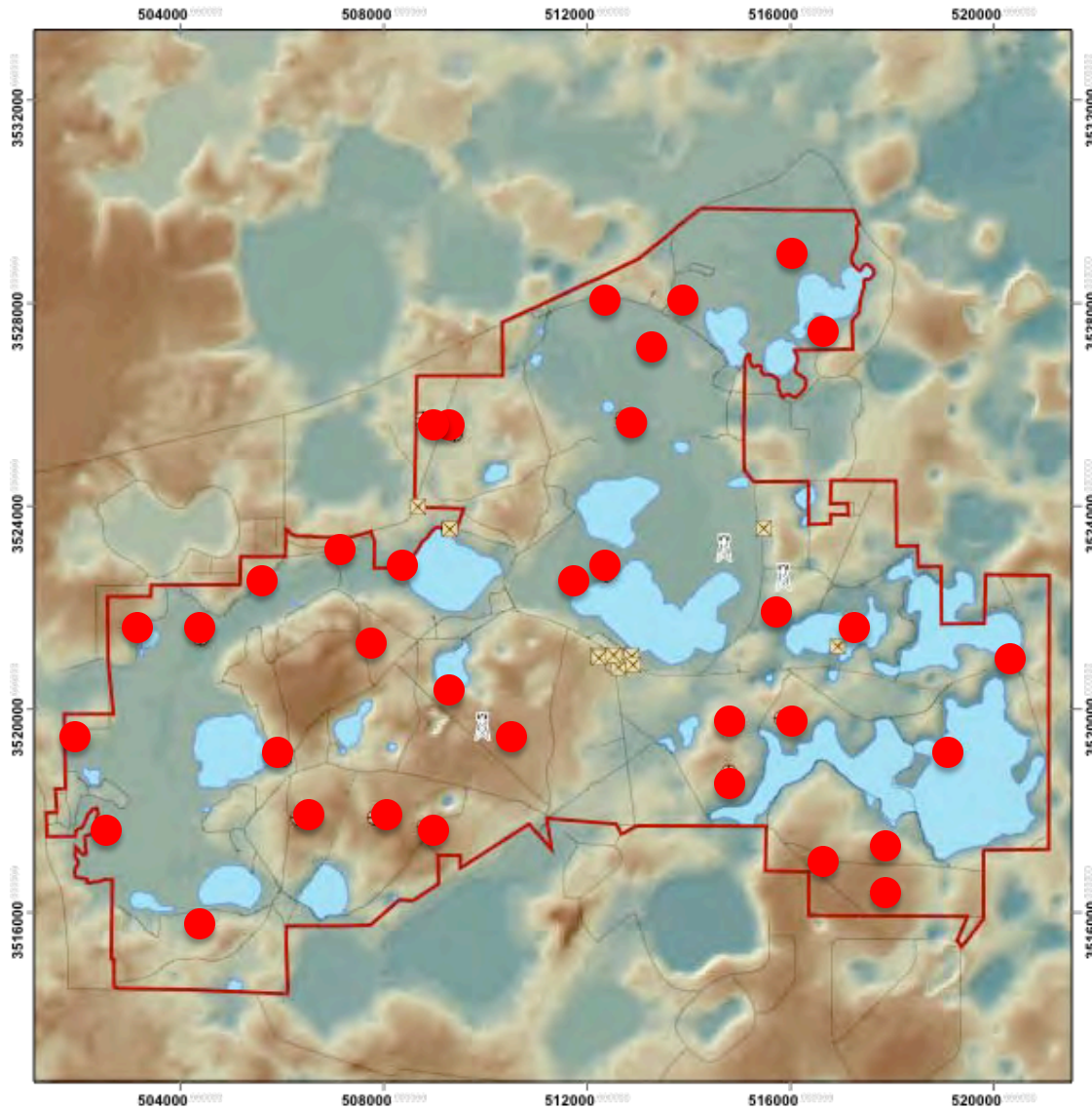


Plant Biodiversity Plots (with associated measurements)



Small Mammal Trapping Design



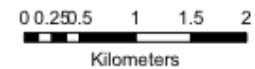
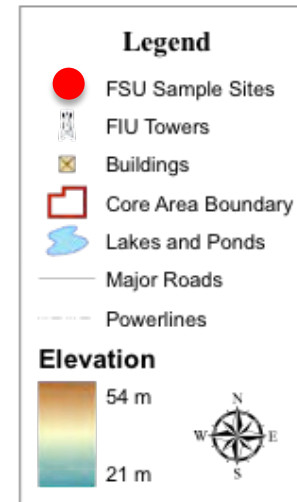


**Domain 3: Southeast
Ordway-Swisher Reserve**

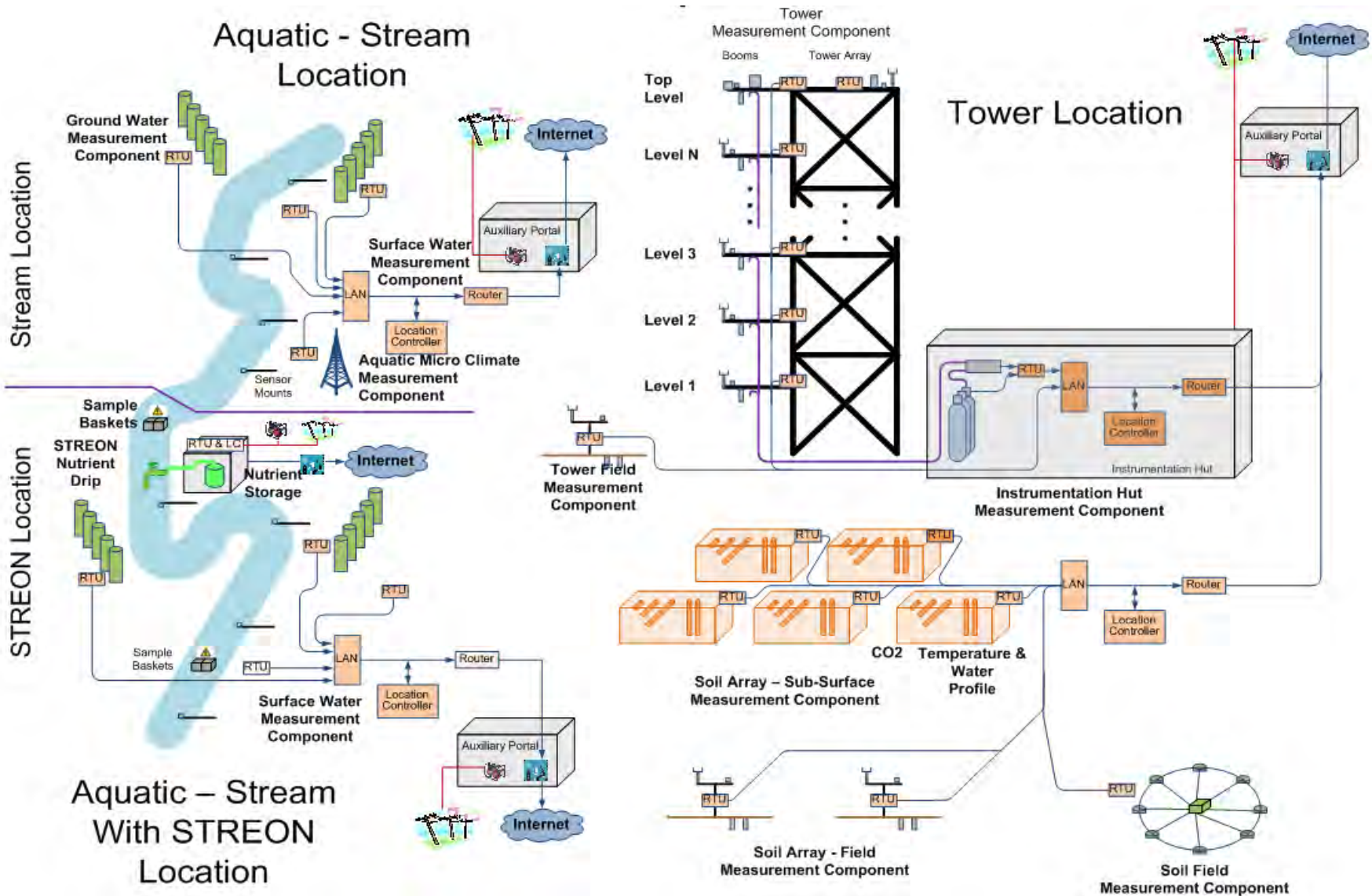
Core Area Site Map

September 24, 2008

Universal Transverse Mercator
Zone 17N
WGS 1984



Sensor Infrastructure

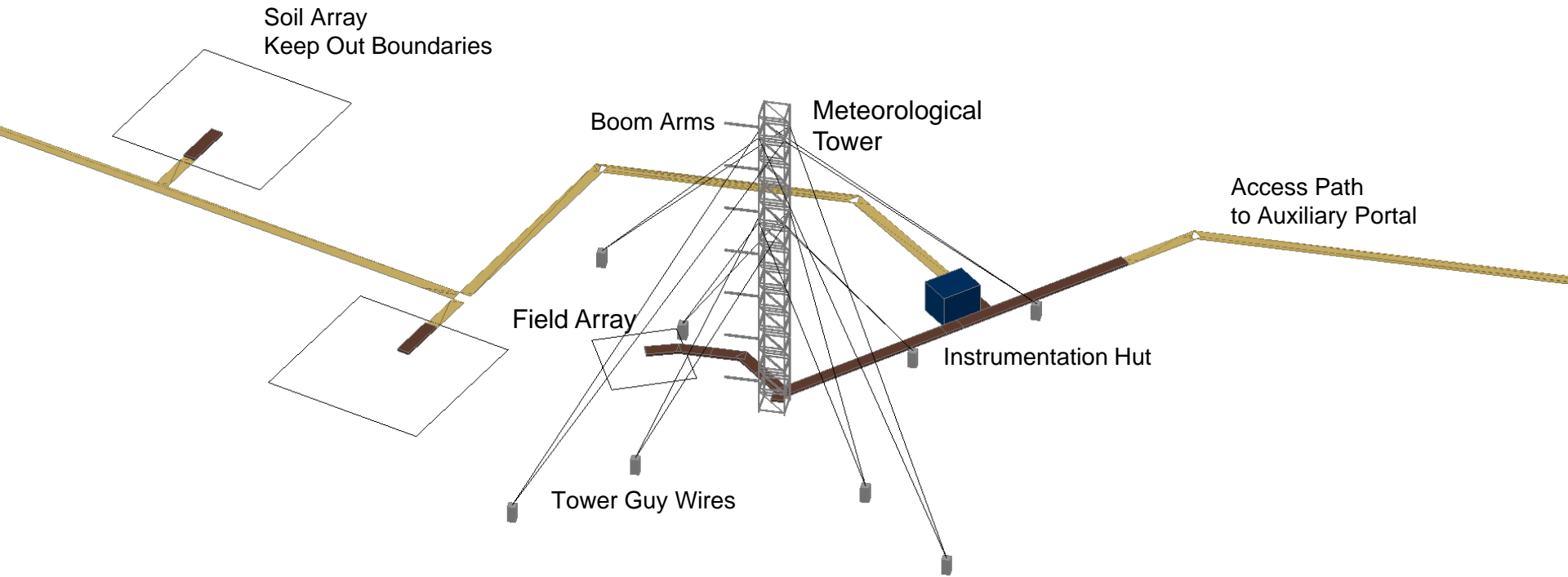


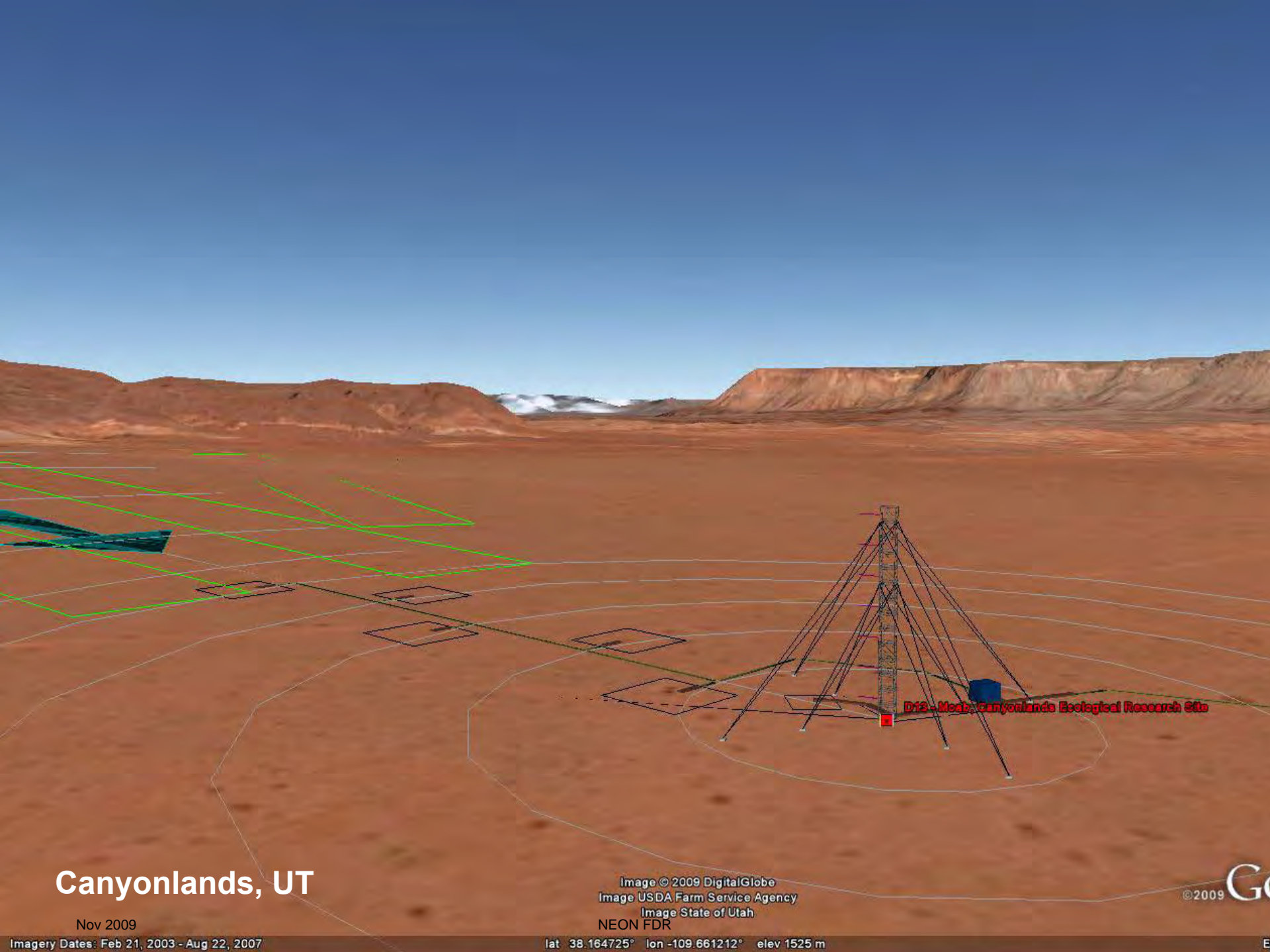
Drivers.....

Tower Sensors

- **Advanced Towers**
 - complete set of measurements – environmental, radiation, atmospheric chemistry
 - core representative site
- **Relocatable Towers**
 - Similar to Advanced; moved every ~5 years to new sites
 - Domain/regionally specific, ecologically significant gradients
- **Mobile Deployment Platforms**
 - Truck or trailer mounted towers with measurement packages
 - Educational packages
 - Rapid response to disturbance/Targets of Opportunity
 - Characterize within and among Domain scales of variance

Tower Sensors -ENG





Canyonlands, UT

Nov 2009

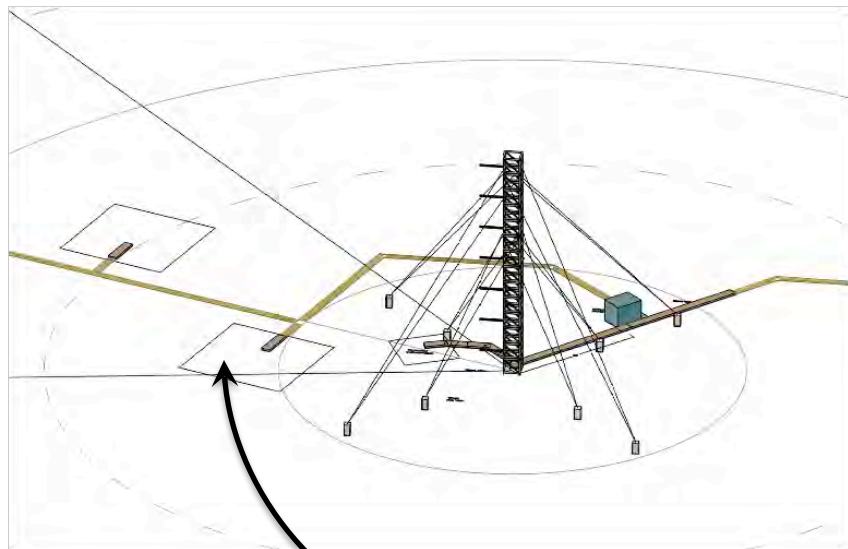
Imagery Dates: Feb 21, 2003 - Aug 22, 2007

Image © 2009 DigitalGlobe
Image USDA Farm Service Agency
Image State of Utah
NEON FDR

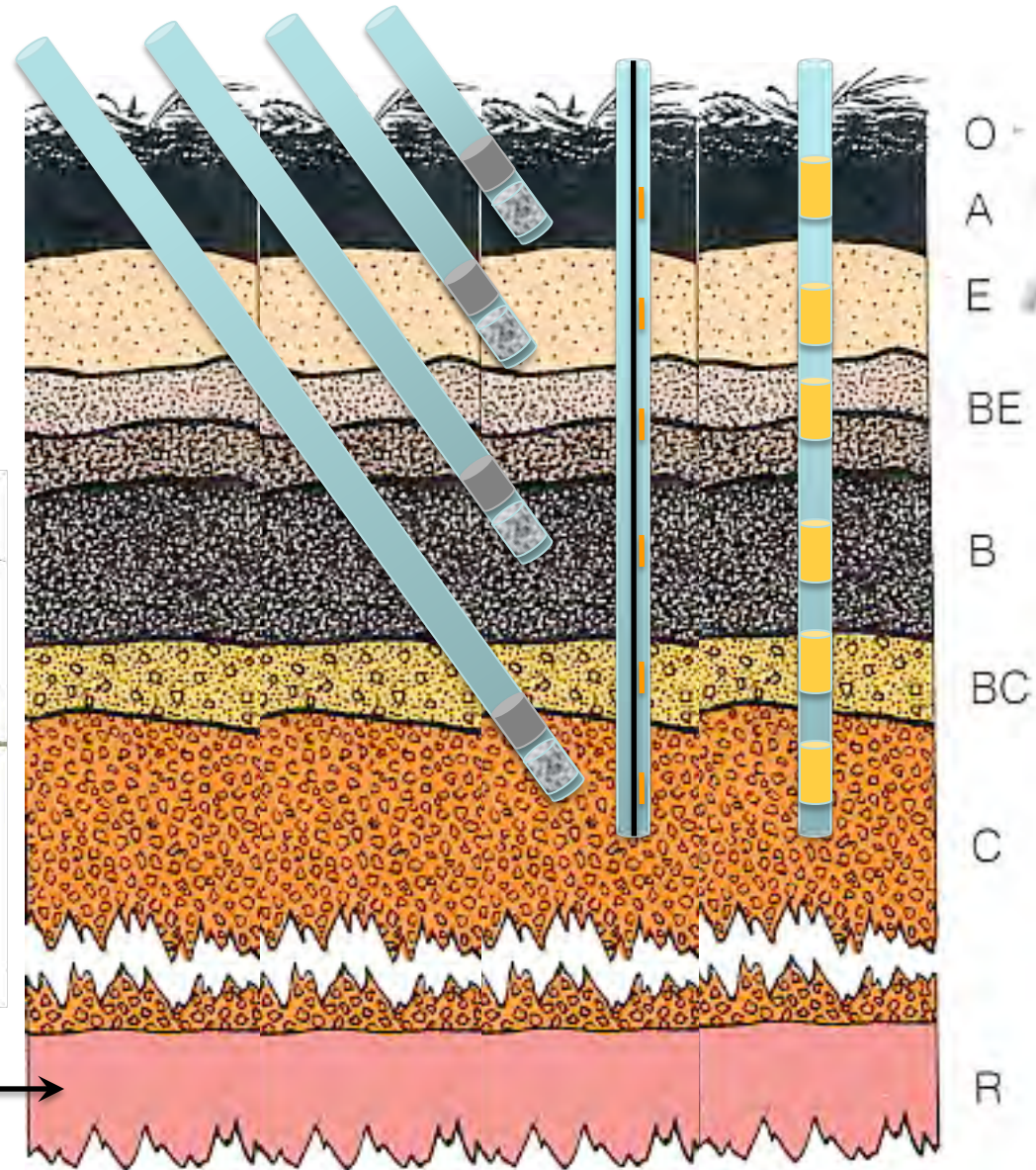
lat 38.164725° lon -109.661212° elev 1525 m

©2009 Go

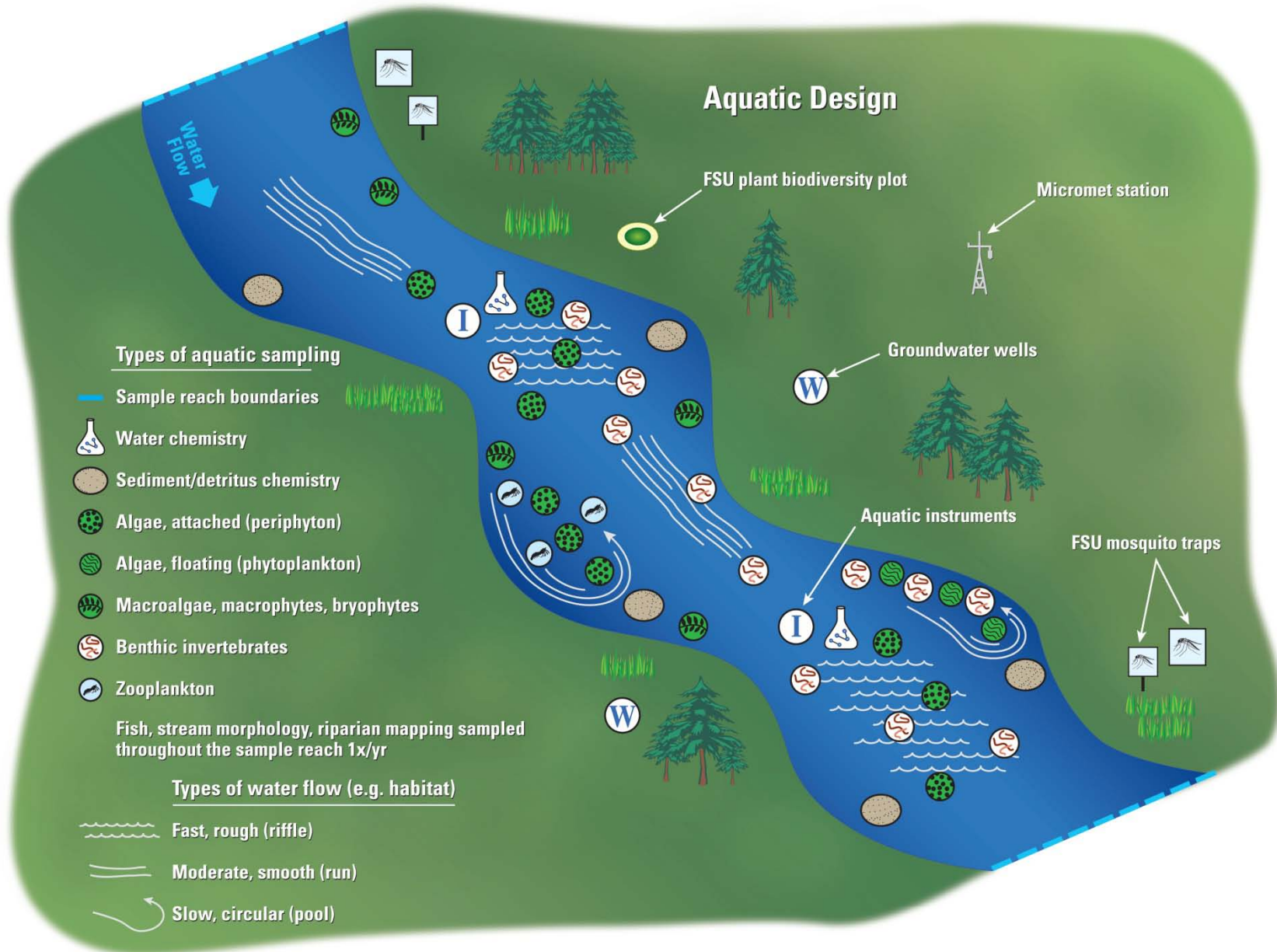
Soil Array Design



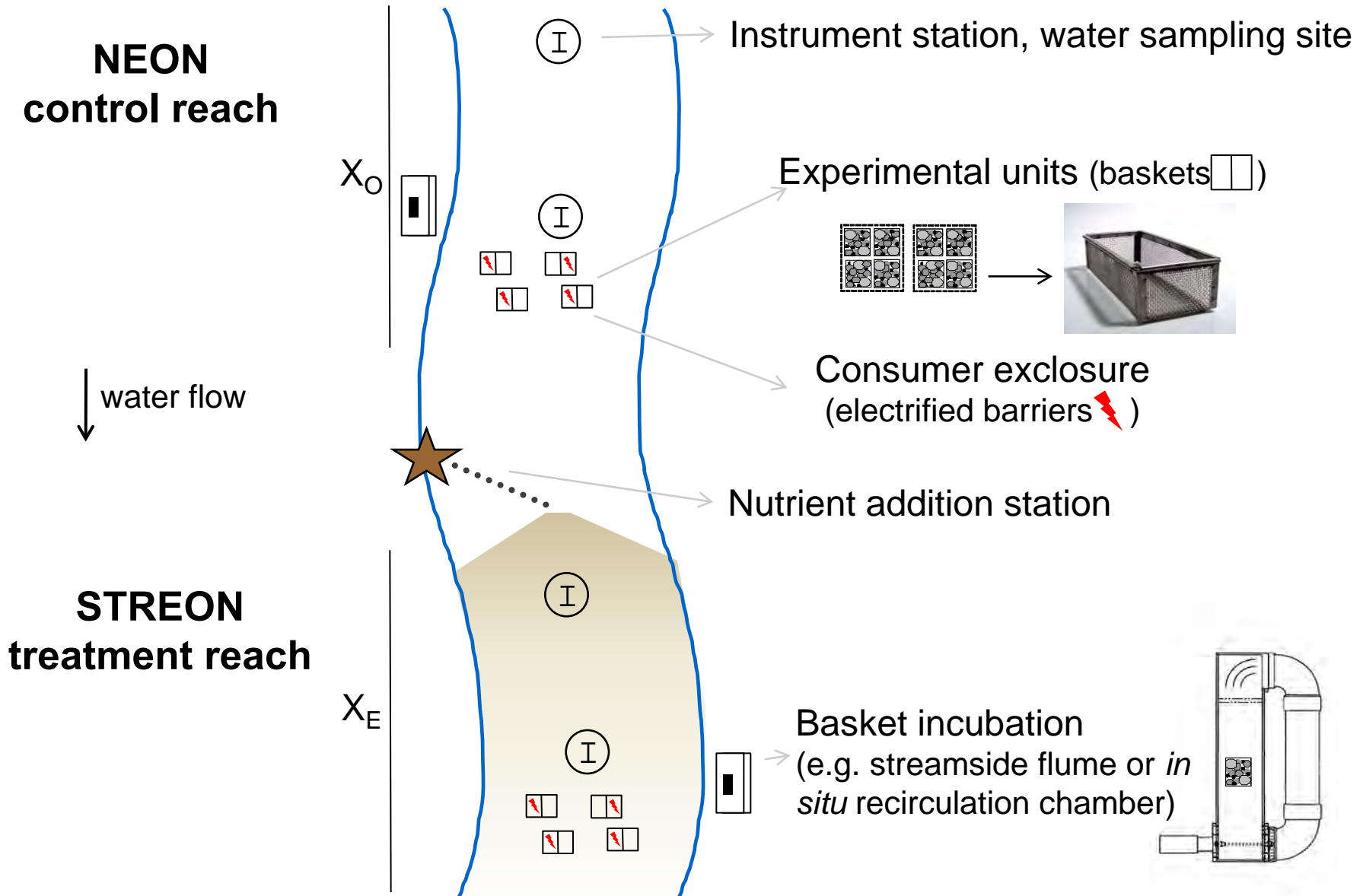
5 replications



A/S -Field Sample Design



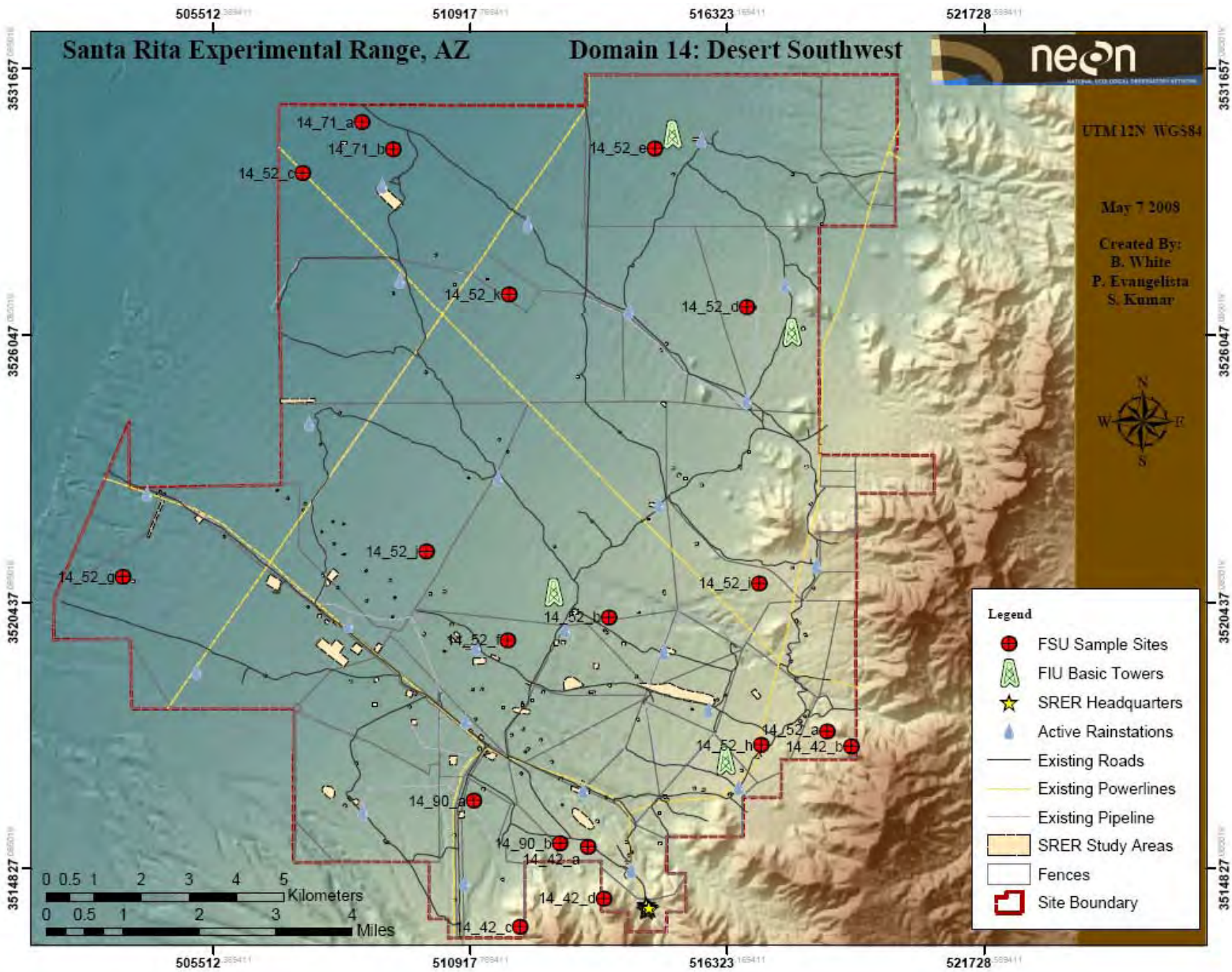
NEON Experiment – STREON (10 sites)



Prototype Site - Table Mountain Test Bed

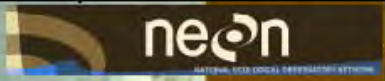


+ tower, aquatic prototypes - 2010



Santa Rita Experimental Range, AZ

Domain 14: Desert Southwest



UTM12N WGS84

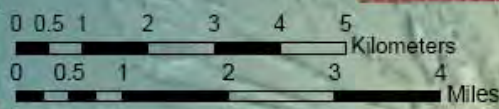
May 7 2008

Created By:
B. White
P. Evangelista
S. Kumar



Legend

- FSU Sample Sites
- FIU Basic Towers
- SRER Headquarters
- Active Rainstations
- Existing Roads
- Existing Powerlines
- Existing Pipeline
- SRER Study Areas
- Fences
- Site Boundary



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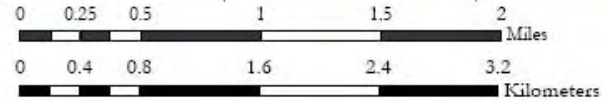
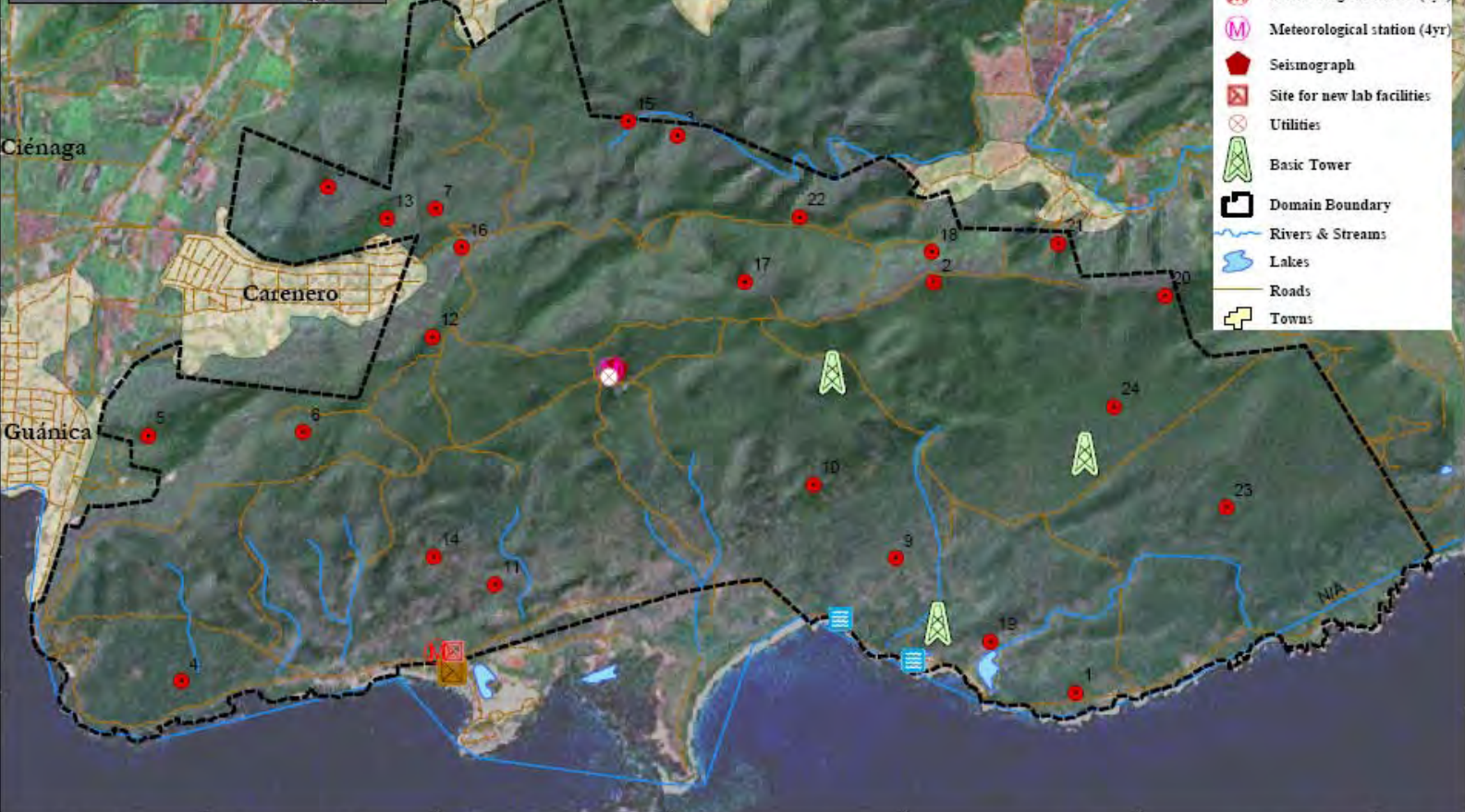
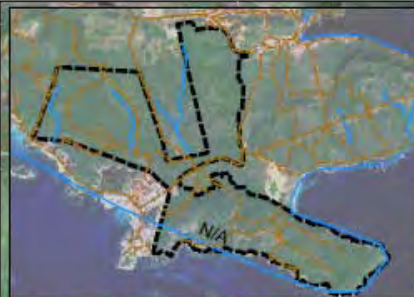
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Domain 4: Guánica State Forest
 WGS 1984 UTM Zone 19N
 March 24, 2007



- Legend**
- potential_sites
 - Structures**
 - ▣ Misc. structures
 - ▣ Hydrological station
 - ▣ Hotel
 - Ⓜ Meteorological station (1yr)
 - Ⓜ Meteorological station (4yr)
 - ⬮ Seismograph
 - ▣ Site for new lab facilities
 - ⊗ Utilities
 - ⬮ Basic Tower
 - ▣ Domain Boundary
 - ▬ Rivers & Streams
 - ▣ Lakes
 - ▬ Roads
 - ⊕ Towns

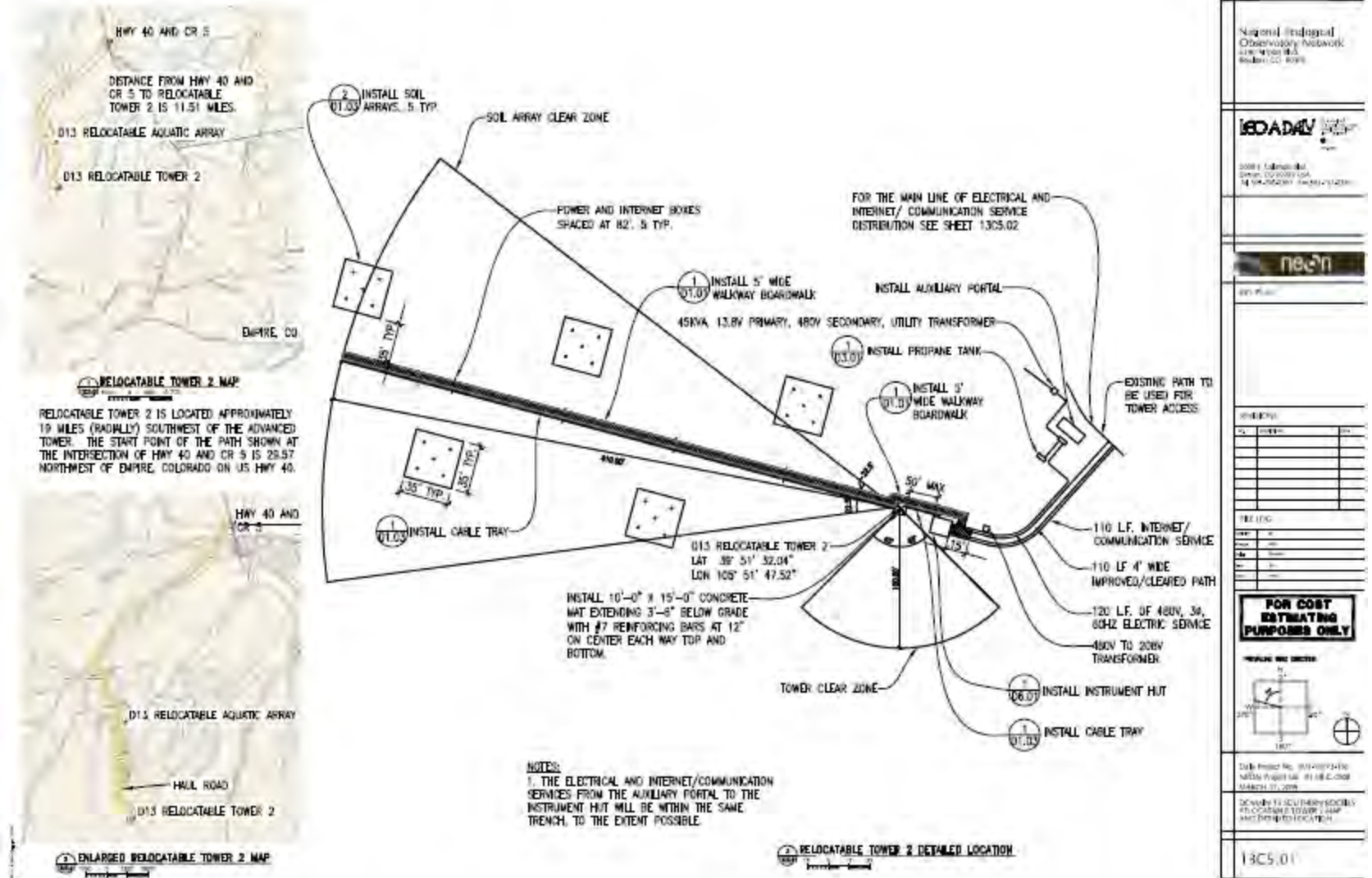


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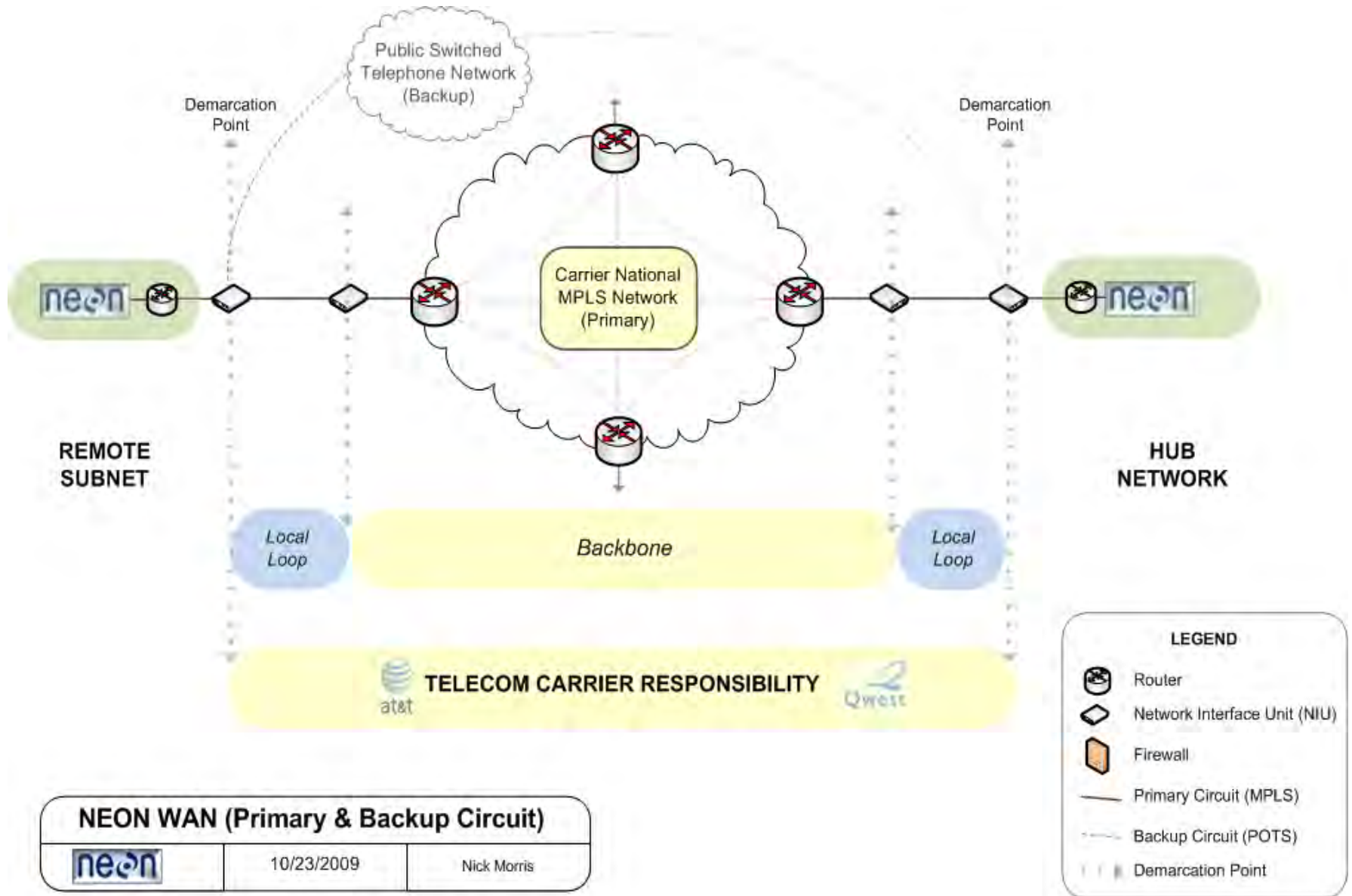


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Site-specific Engineering Designs – 62 Locations



Domain Network Design



NEON WAN (Primary & Backup Circuit)		
	10/23/2009	Nick Morris

Supporting Facilities

- Chemical analysis resources
- Isotopic analysis resources
- Genetic analysis resources
- Disease facility
- BioArchive collections

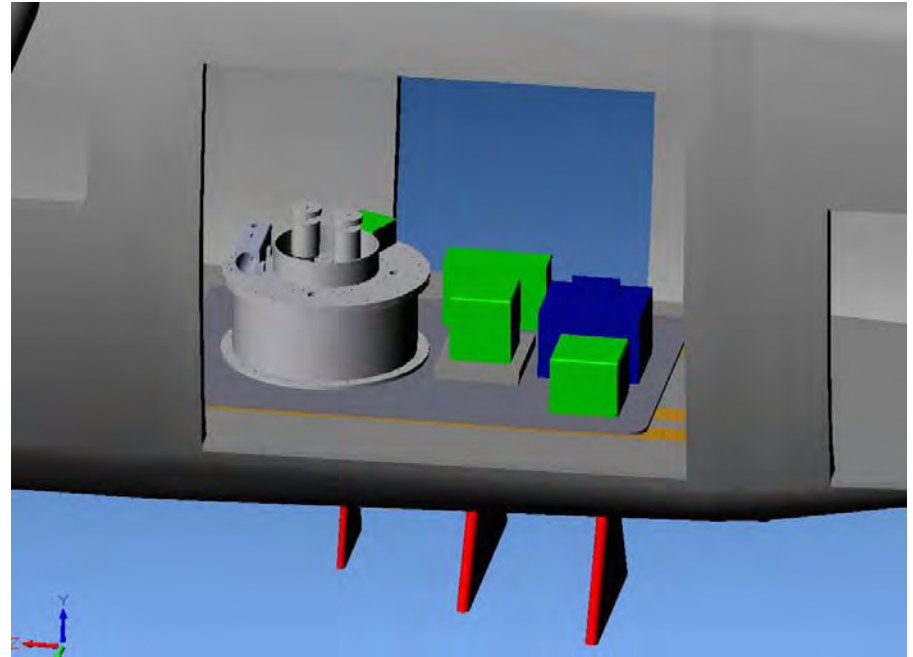
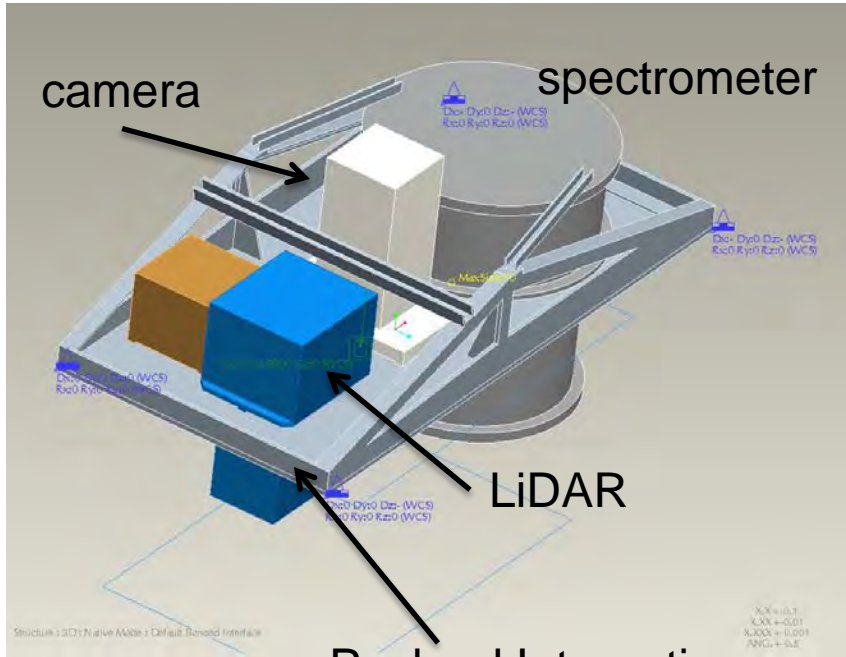
- Headquarters - Boulder
- Engineering labs, data center, science, Education, mgnt/admin
- **Calibration/Validation Laboratory**
- Advanced Development Lab (skunkworks)

Airborne Observation Platform (AOP)

- Sub-regional scale sampling ($\sim 400 \text{ km}^2$)
- 3 Aircraft Platforms
- Annual repeat for core and relocatable sites
- Intensive sampling at a subset of sites + TOO
- Vis-IR spectrometer
- Waveform LiDAR
- Digital Camera
- Vegetation structure and biochemistry



Integrated Payload



Payload Integration
mount (PIM)

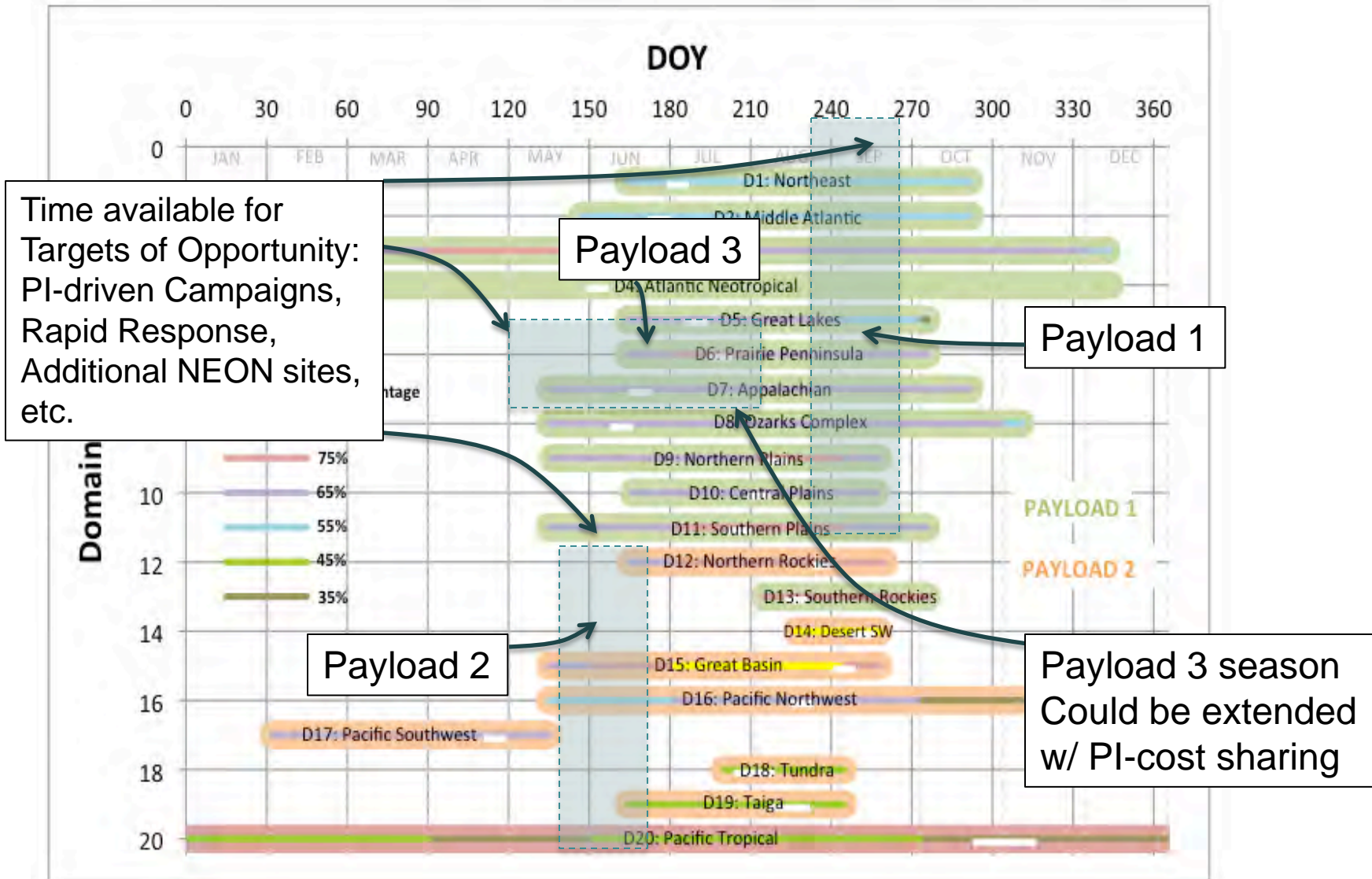
Baseline Aircraft: Twin Otter



- Accommodates baseline payload with some room to grow
- Low stall speed, excellent low speed handling and stability
- Safety: Two engines, excellent track record
- Two engines eliminates prop wash issues
- Rugged, easy to maintain, easily modified
- Well-known to scientific researchers (used by NOAA, NASA, DoD, etc. regularly in the field)

Parameter	AOP Platform Requirement	DeHavilland DHC-6-300
Target Ground Speeds	90 – 110 knots	80 – 175 knots
Cruise Speeds	> 150 knots	Up to 175 knots
Survey Altitudes	3280 – 9843 ft AGL	Up to 25,000 ft ASL
Science Instrument Power	> 3880 W (139 Amps @ 28 VDC)	8400 W Max Scientific Power (300 Amps @ 28 VDC)
Payload Accommodation: Integration	> 4 ft wide cabin door	4.7 x 4.2 ft
Payload Accommodation: Weight	700 lbs + 2 crew	4500-7000 lbs useful load
Payload Accommodation: Volume	Sensor head approx 2.5 (H) x 2.4 (W) x 4 (L) ft 2 standard electronics racks	4.9 (H) x 5.27 (W) x 18.5 (L) ft

AOP Scheduling



Time available for Targets of Opportunity: PI-driven Campaigns, Rapid Response, Additional NEON sites, etc.

Payload 3

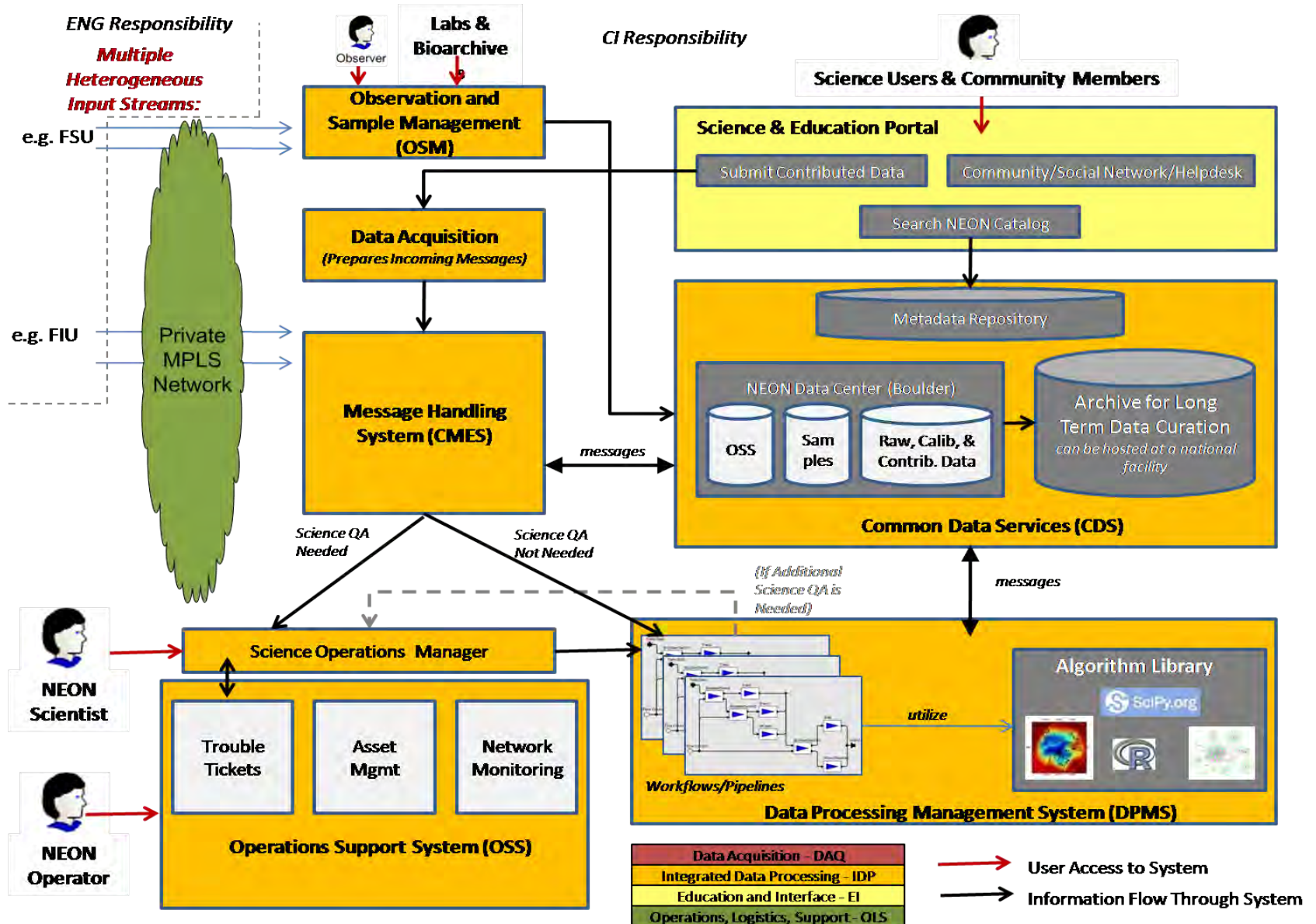
Payload 1

Payload 2

Payload 3 season Could be extended w/ PI-cost sharing

White bars represents AOP data collection at each domain

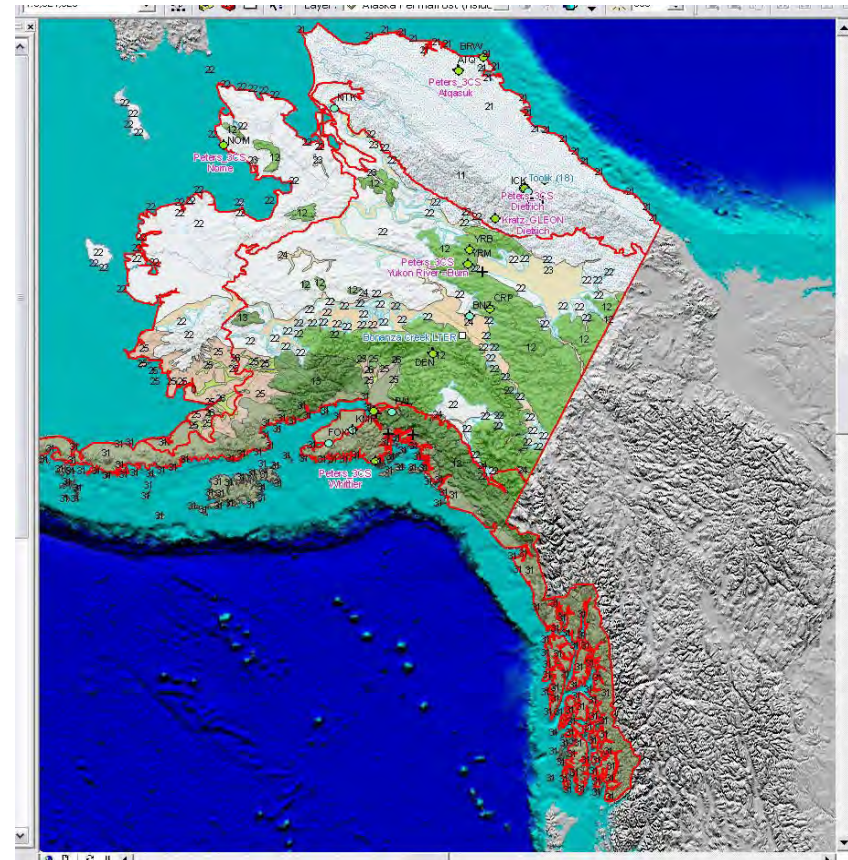
NEON Cyber Infrastructure



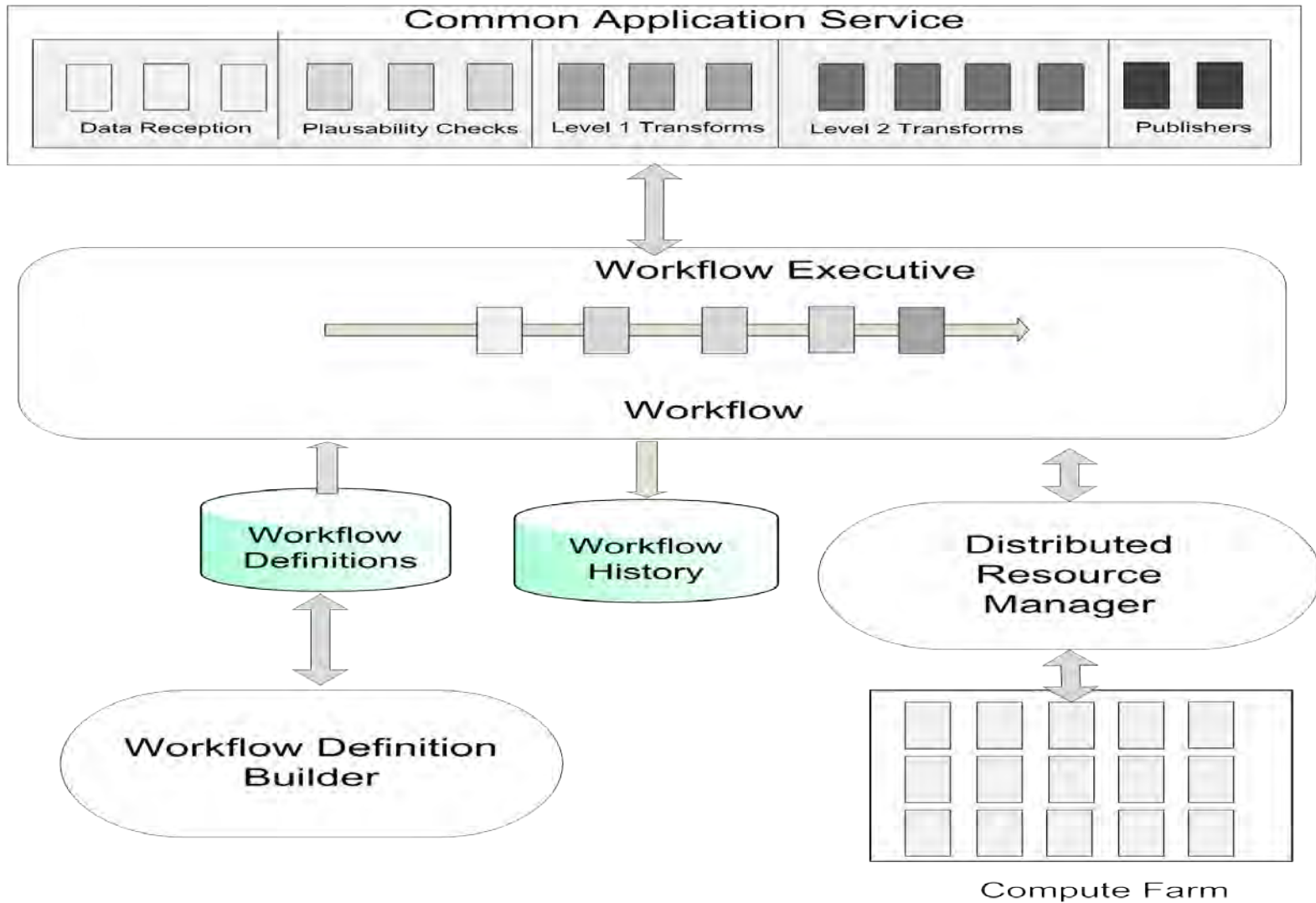
Land Use Analysis Package (CI/LUAP)

Accessing larger spatial datasets....
USGS, NASA etc.

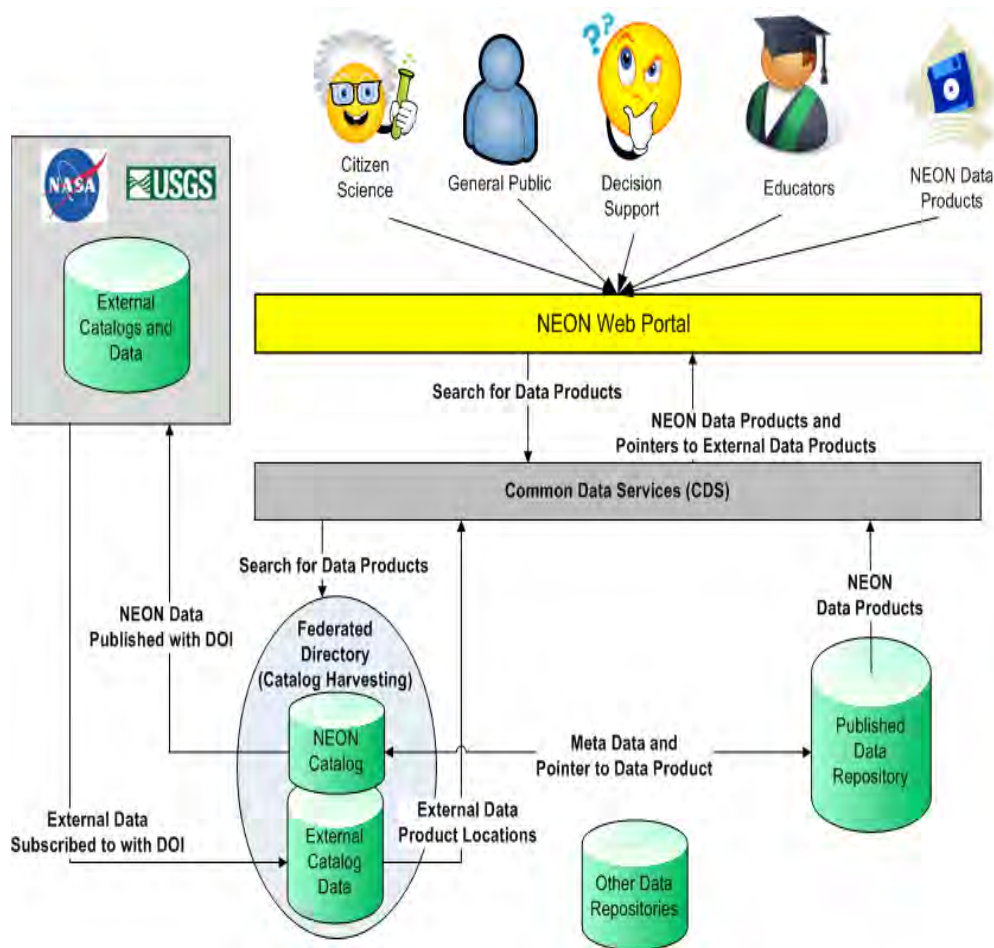
- Continental coverage
- Land cover
- Land use
- Vegetation biophysical properties
- Geographic data including census data
- User interface to facilitate geographic analysis by the non-specialist



High Level DPMS View - CI

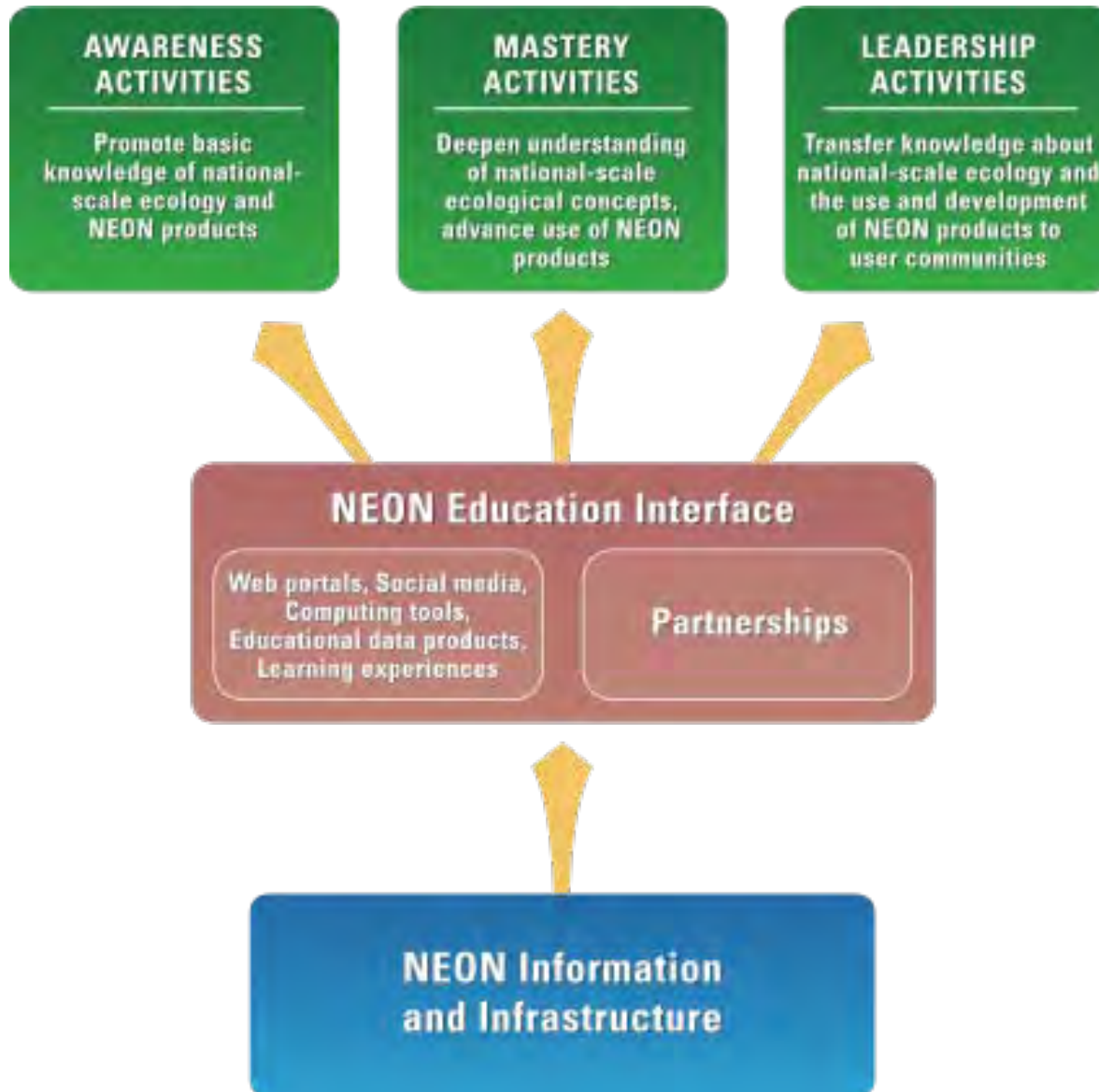


Portal



- Disseminate information
 - Science of continental-scale processes
 - Resources for communicating that science
 - Situate events within the context of that science
 - Enable discovery of internal and external data products
 - Deliver data in a number of well-known binary and text formats. (e.g. HDF, netCDF, CSV)
- Collect information
 - Data from citizen-scientists
 - Usage patterns
- Architecture
 - Use consistent web framework
 - Enable federated data catalog through DOI

Education



NEON Satellite Sites

- NEON technical/CI/operational definition: open to community
- Idea: sites/institutions may set up their own (subset) of the NEON infrastructure (FIU, FSU/A), adopt NEON standards for Cal/Val etc., feed data back to NEON archive.
- Collaboration: NEON and Science-Engineering Alliance (SEA)
- PI: Robert Shepherd, PM: Don Bowie
- Initial work: review NEON technical definition for “openness”
- Several interaction models to consider....
- Training & development: TMTB
- NEON impact: small; community impact: large...

NEON

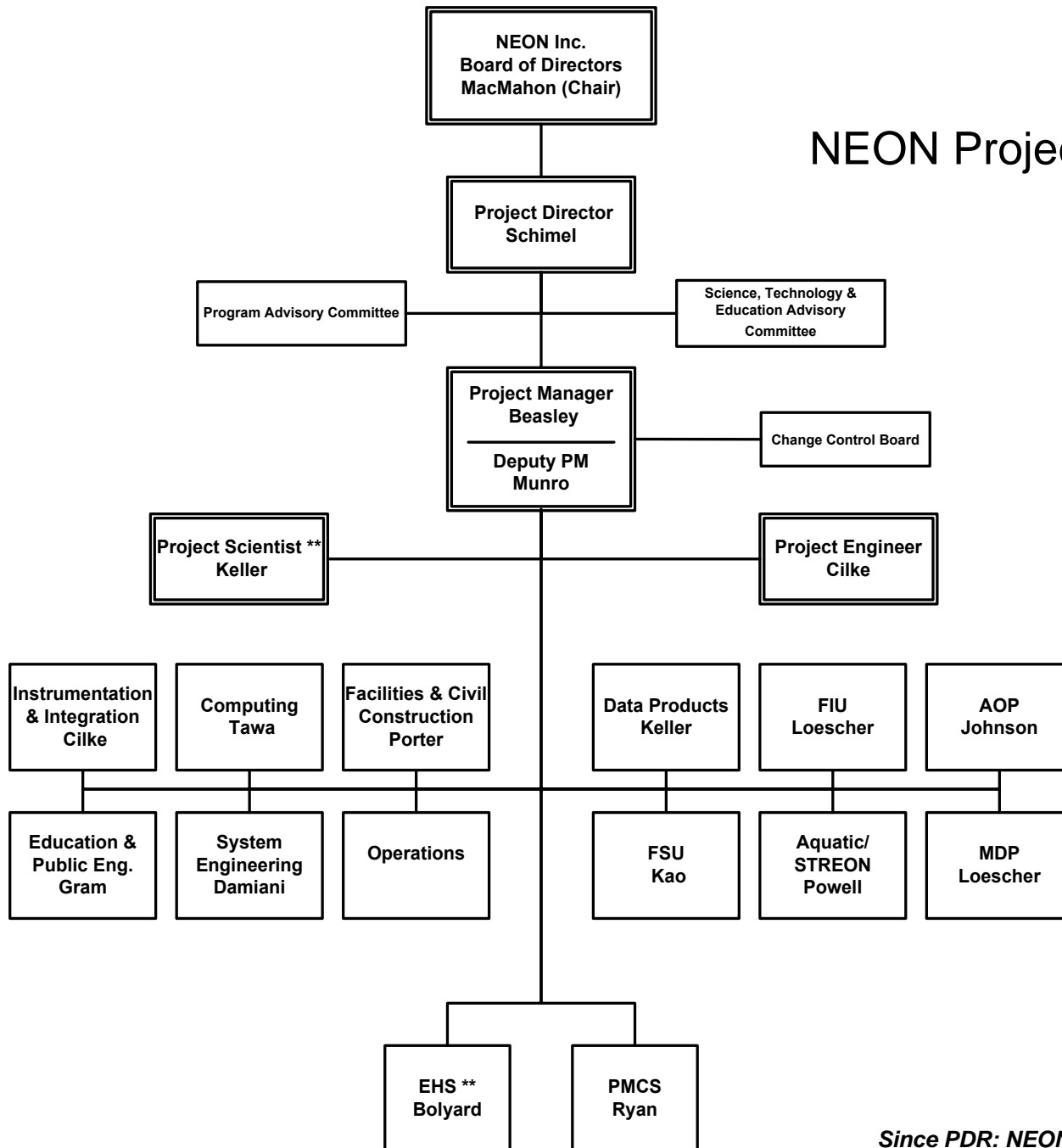
- Observe drivers of and responses to ecological change...
- 20 domains (ecosystems) – radiation, atmospheric, soil, aquatic measurements (drivers) + FSU sampling (responses).
- Advanced/relocatable/mobile/aquatic measurements.
- Domain office/lab/staff – support (x20)
- Supporting facilities – analytical labs, bioarchives (outsource)
- Airborne Observation Platform – survey domain sites, TOOs
- Headquarters – construct/operate Observatory, central labs
- Cyberinfrastructure – proc/store/publish data, monitor Obs
- Scientific staff – data QA/QC, program design/update
- Scientific data products + taskable facilities ← community/NSF

NEON Construction Project

Modern History

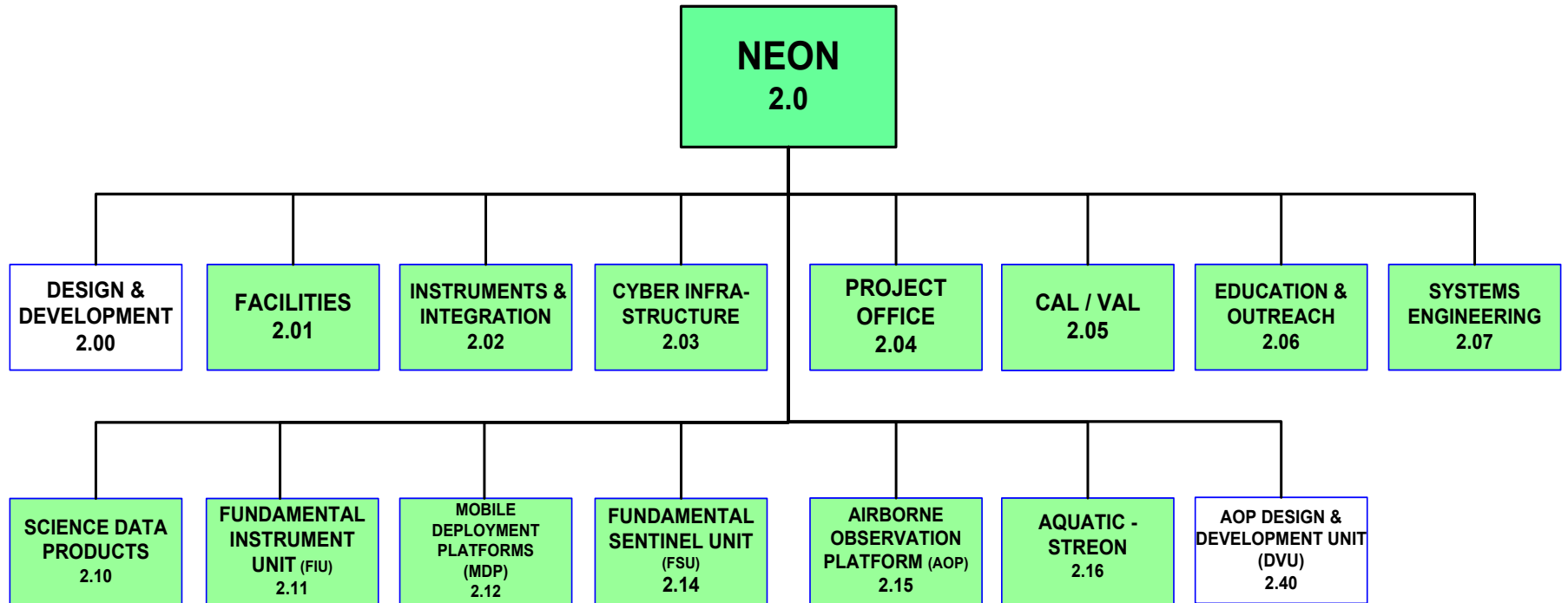
- Prior to 2006 ... Community organization/meetings led to...
- 2006 ... Integrated Science and Education Plan (ISEP).
- 2007 ... PDR1: NEON needs further D&D.
- 2008 ... new D&D phase: flowdown & deliverables, site design contract underway, project office ramp-up (6-50 staff).
- Dec 2008... STEAC Science review.
- Feb 2009 ... NEON Science Review (NSF).
- April 2009 ... Subsystem reviews (AOP,CI,FSU,FIU,EDU).
- April 2009... site design estimates: enabling (de)scoping, Operations estimation.
- June 2009 ... PDR – comments, action items...

NEON Project Structure

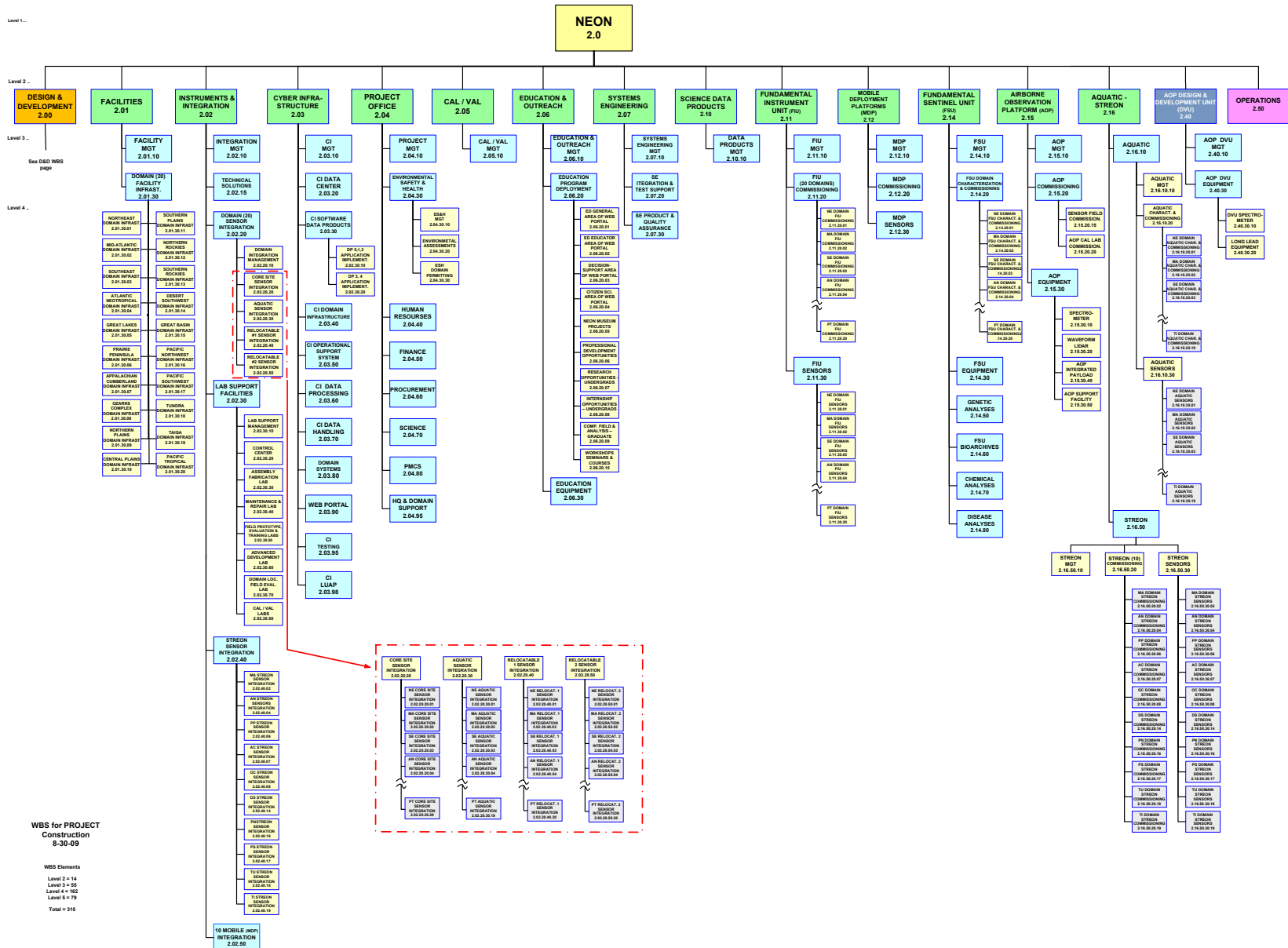


Since PDR: NEON, Inc., Ops, Sys Eng

NEON Construction WBS



NEON Construction WBS



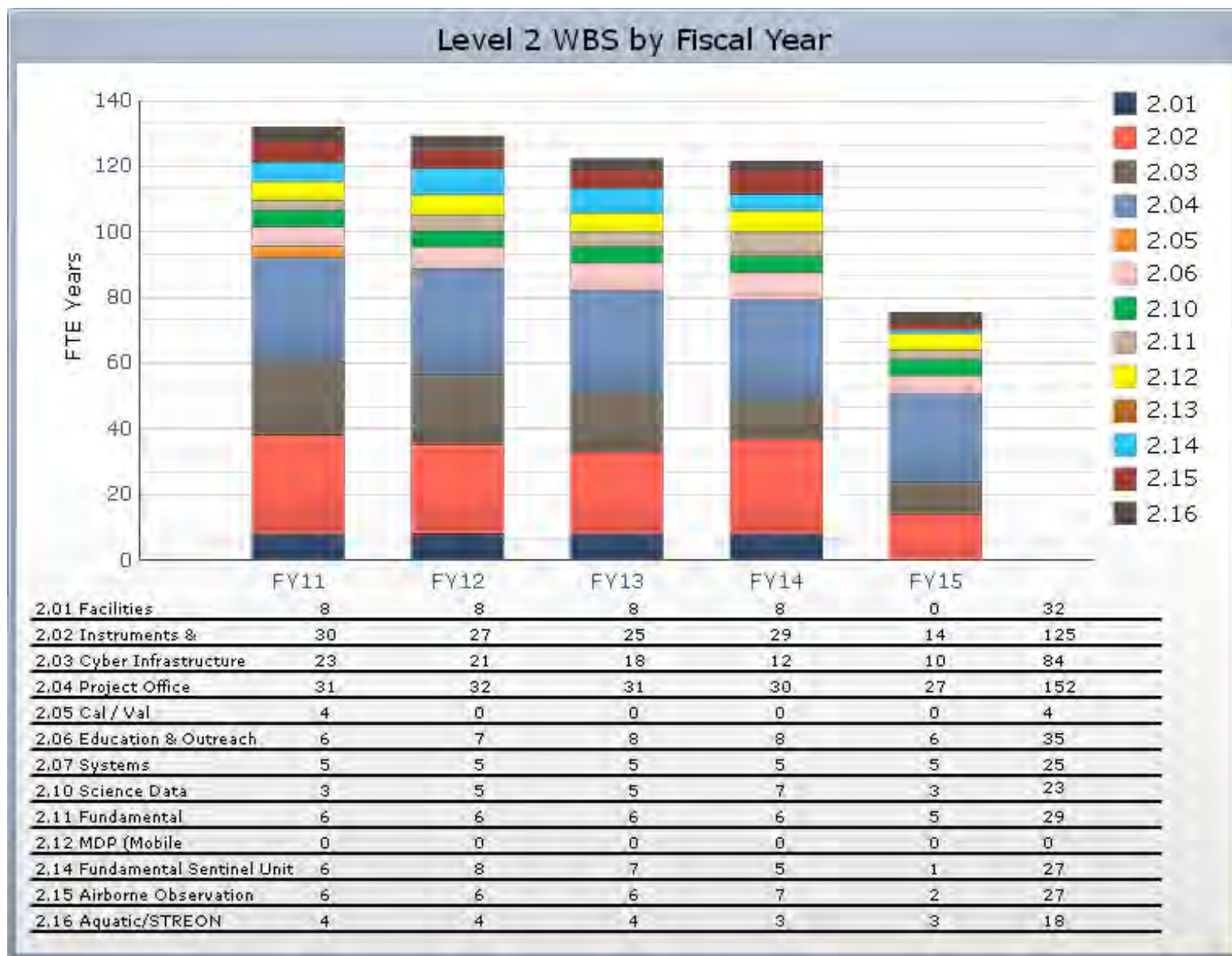
See D&D WBS page

WBS for PROJECT Construction 8-30-09

WBS Elements

Level 2 = 14
 Level 3 = 55
 Level 4 = 582
 Level 5 = 79
 Total = 350

FTE by WBS & FY



NEON Risk Summary

		Total Number of Risks				
Probability	0.9	1			3	1
	0.7		2	2	1	2
	0.5	3	4	16	5	9
	0.3	1	11	28	11	12
	0.1	4	10	11	13	6
		1	2	3	4	5
		Impact				

Total Number of Risks	156
Total Occurrence Cost of Risks	\$ 54,588,040

Near-Term Risks	6	<p>~ Risks across project phases (D&D, CSTR, and OPS)</p>
Mid-Term Risks	122	
Far-Term Risks	14	
Past-Term Risks	14	

		Near-Term Risks				
Probability	0.9					
	0.7					
	0.5		2	1		
	0.3			2		
	0.1				1	
		1	2	3	4	5
		Impact				

		Mid-Term Risks				
Probability	0.9	1			3	1
	0.7		1		1	2
	0.5	2	2	10	3	8
	0.3	1	10	20	9	9
	0.1	3	10	11	10	5
		1	2	3	4	5
		Impact				

		Far-Term Risks				
Probability	0.9					
	0.7		1	2		
	0.5	1		3		
	0.3			1		3
	0.1	1			1	1
		1	2	3	4	5
		Impact				

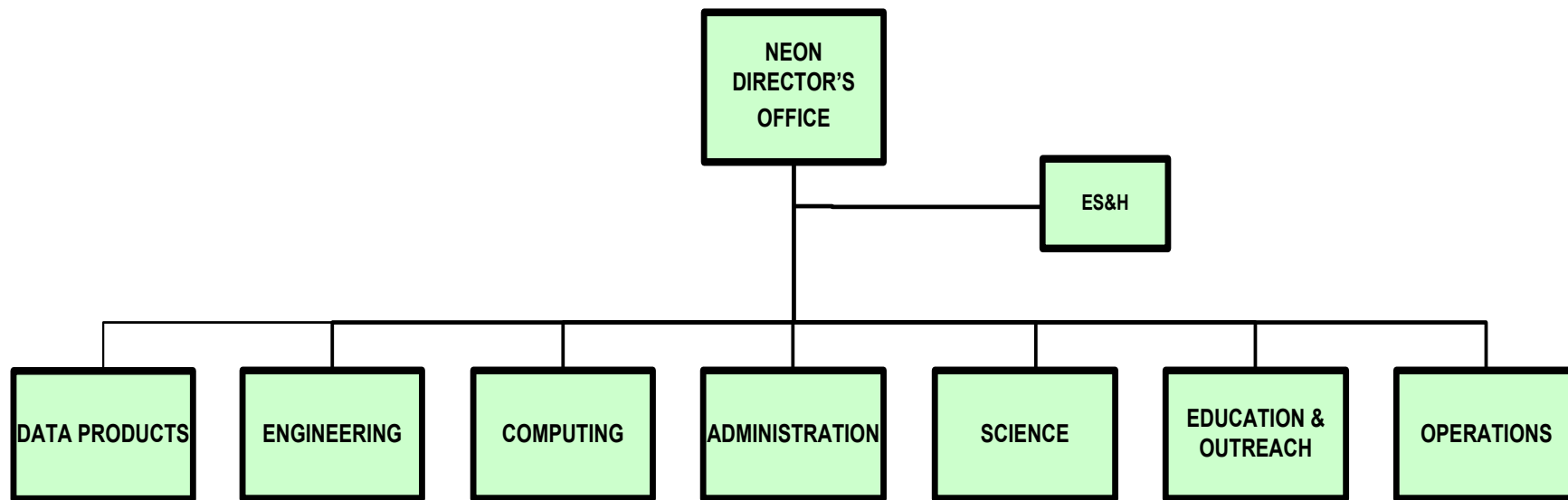
Standard Project infrastructure

- Project Management Control System - PMCS
- Electronic Document Management System - EDMS
- Configuration Management, document control procedures
- Change Control Board – active
- Earned Value Management System – testing
- Communications – weekly/monthly grid spanning project
- Budget/schedule/risk monitoring
- Sub-projects underway
 - NIS-DVU AOP spectrograph
 - D&D/Bridge – prototyping activities

Operations

- Operations Plan draft: Version B
- Based on existing ecological, astronomical observatory models. (similar)
- Key parameters include:
 - Support staff in the domains: number, availability, skill sets,....
 - Scientific staff for data QA at HQ
 - MTBF/MTTR of equipment, infrastructure
 - AOP: fuel, plane availability
 - AOP scheduling & TOO
 - Power/communications to sites
 - Data policy; Relocatable strategy; MDP policy

Observatory Org



Operations – next steps

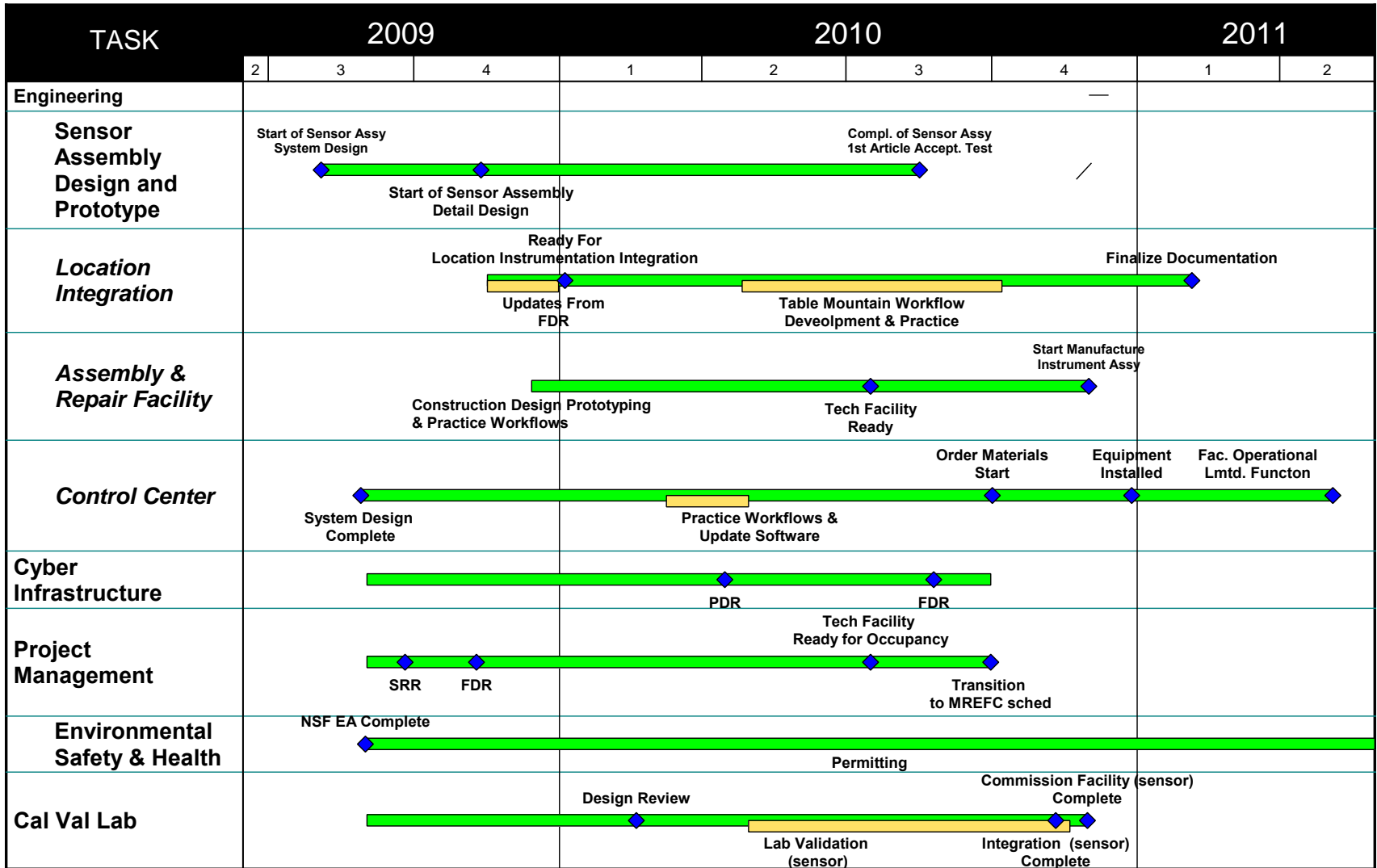
- Current estimate = sum of parts with some 15% factors; continuation of construction project mindset... ??
- Major components: FSU fieldwork, Domain M&O, staffing..
- Operations Working Group established – gather community, org advice.
- New Director of Operations – analysis underway
- Estimate: conservative, compressibility unknown.

- Major Operations Review – April 2010.

Preliminary Design Review – June

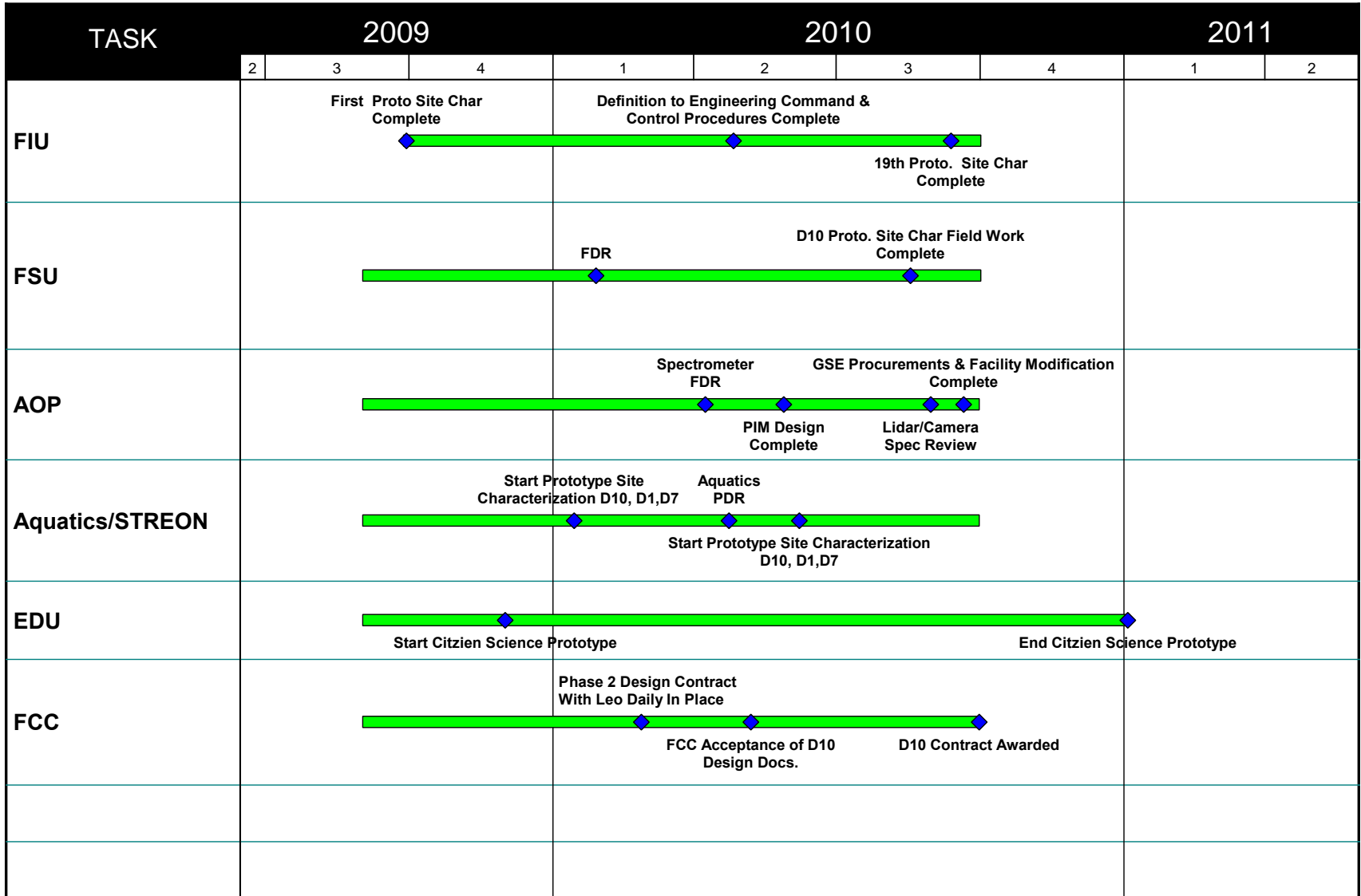
- Requirements management improved, under control – ongoing
- Integrate risk register, schedule – done
- Improve cost effectiveness – ongoing, will be explained (e.g. CI)
- Simplify contingency – done
- Simplify project organization, make SE more visible – done
- Develop scope management plan – done
- Improve availability, operations analysis & plan – ongoing
- Reevaluate permitting complexity, risk – done, ongoing...
- Expose IVVC scheme, plans, procedures – done
- Reevaluate AOP performance (Cal, lost time, etc.) – done
- Prototype citizen science web portal – planned (Bridge)
- Define tower plans – done

NEON Summary Schedule Design & Development Phase



NEON Summary Schedule

Design & Development Phase



Issues

- Site access: EA, permitting & weather
- Domain staff: NEON, contractors... availability, skill sets, training, institutional memory, etc. Soln: specific hiring initiatives, staff training, good salaries, collaboration.
- Management: Continental-scale research and national observatory approach is a new paradigm for ecology... formal project management new.
- Scientific expertise & volume of information... challenges...
- Technical: ok; reasonable step beyond state-of-art; programmatic/organizational complexity
- Funding profile: steady source to enable optimized planning

Issues

- Commodity exposure (~moderate)
 - Steel, oil - e.g. AOP operations // Fine-tuning of Operations tasking
 - Silicon – A few DPs need significant compute power // Background
- Environmental & permitting
 - Bolyard talk – this afternoon; Schedule analysis - Wednesday
 - NSF Environmental Assessment – ~complete, no issues (high level).
 - Permitting: underway.... 1/3rd easy, 1/3rd hard, 1/3rd ok. 20-50 permits per site.
 - D10Ready – successful.
- AOP spectrograph – NIS-DVU – project funded, underway; mitigate AOP risk (delay).
- Infrastructure Requirements – Observatory Requirements Doc and System Requirements Review – successful (with actions underway)

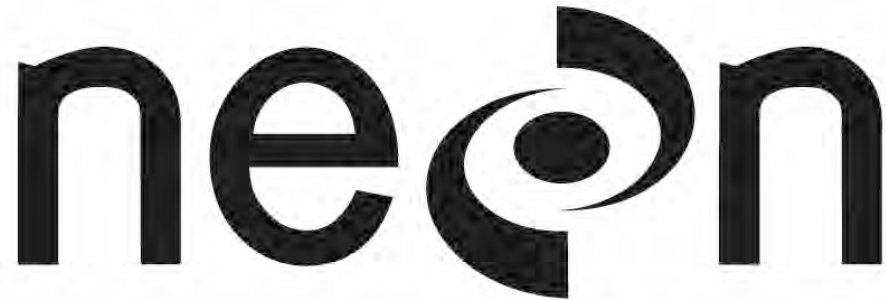
Summary

- NEON, Inc. company: completed, online.
- Project definition/cost estimation completed, revised.
- Project management procedures in place.
- Operations: Ongoing planning, estimate refinement.
- “Bridge funds” – risk mitigation/prototyping/facility preparation and additional site characterization planned, followed by transition to full construction.

- Review: improve NEON project definition.

FDR Information

- Info
 - Website – documents + draft presentations (selected)
 - Memory sticks – complete set (docs + final presentations) plus supporting materials (PDR report; talk – session correspondence sheet).
 - Posters – break/lunch discussions. PTLs available.
- Talks
 - Today – intro to all major subsystems, estimation process
 - Tue/Wed - breakout sessions reviewing scope, budget and schedule, project processes, etc.



NATIONAL ECOLOGICAL OBSERVATORY NETWORK

The National Ecological Observatory Network is a project sponsored by the National Science Foundation and managed under cooperative agreement by NEON Inc.