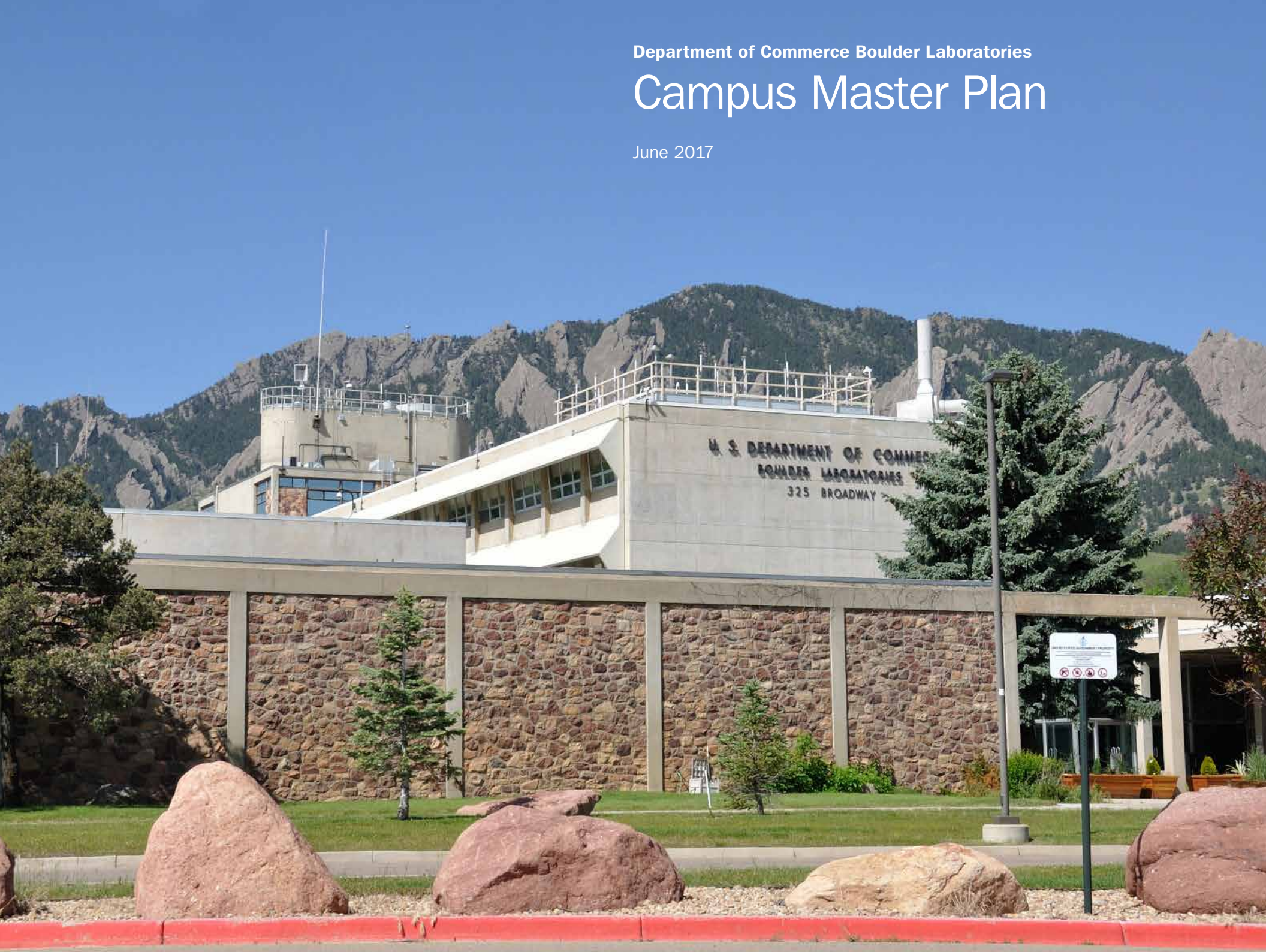
Department of Commerce Boulder Laboratories

Campus Master Plan

June 2017



Department of Commerce Boulder Laboratories

Campus Master Plan

June 2017

National Institute of Standards and Technology
Boulder, Colorado

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DOCBoulder Laboratories

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1 Executive Summary

THE Department of Commerce research campus at Boulder has a beautiful setting, with Kohler Mesa and the Flatirons as a backdrop to the buildings and landscape. The 206-acre campus is home to research programs of the National Institute of Standards and Technology (NIST), the National Oceanic and Atmospheric Administration (NOAA) and the National Telecommunications and Information Administration (NTIA), with a 2015 total of 1776 research scientists, engineers, administrators and support personnel. There are 29 occupied buildings on campus, plus 5 structures enclosing mechanical equipment or other infrastructure.

The National Institute of Standards and Technology at Boulder has four laboratory components located here: Communications Technology Laboratory (CTL), Information Technology Laboratory (ITL), Material Measurement Laboratory (MML) and Physical Measurement Laboratory (PML). These laboratories, together with administrators and support groups, have approximately 740 employees and affiliates on campus. Research is conducted in the areas of materials reliability. opto-electronics, quantum electronics and physics, time and frequency, and electromagnetics.

The National Oceanic and Atmospheric Administration at Boulder conducts research in atmospheric and space sciences, with approximately 950 employees and affiliates, including GSA operations and management personnel. Three research, forecasting and information programs share the NOAA campus facilities: the Office of Oceanic and Atmospheric Research (OAR), the National Weather Service (NWS) and National Environmental Satellite Data and Information Services (NESDIS). OAR's Earth System Research Laboratory has approximately 640 of NOAA's personnel.

The National Telecommunications and Information Administration has one laboratory headquartered at the Boulder campus, the Institute for Telecommunication Sciences. This group, with approximately 70 people, researches cutting edge areas of telecommunication technology, principles and applications. They work closely with PML's time and frequency research components and with CTL.

1.1 Master Plan Goals

The Department of Commerce (DoC) requires that its agencies have a physical master plan for their sites, reflecting both the anticipated special needs of the user groups and the impact of its activities on the surrounding community. The master plans are used to identify needed physical facilities, advance the agency's mission-related goals and develop a more efficient, flexible campus. Although this Master Plan for the Boulder Laboratories was commissioned in response to institutional policy, another factor also drove the request—the evolving mission of the laboratories and the greater demand for highly controllable research environments.

Both the campus and research programs have changed since a 1992 Site Development Plan, and today modernized laboratory space and flexible, integrative and collaborative space are needed to promote advancing research. The Master Plan is a supporting tool to meet the articulated campus goals of the administrators, scientists and staff, including:

- A plan that creates a comprehensive and coordinated framework for physical development of the Boulder campus;
- A plan that develops appropriate facilities and infrastructure for the evolving and advancing scientific research;

Exhibit 1: Existing Site Plan

01	Radio Building	09	Gas Meter Building	33	David Skaggs Research Center
01C	Building 1 Annex C	11	Ionospheric Ovservatory	34	NOAA Observatory
01D	Building 1 Annex D	12	Hydrogen Test Facility	41	High Speed Switch
01E	Building 1 Annex E	21	Maintenance Garage	42	Central Utility Plant
01F	Building 1 Annex F	22	Warehouse	51	Security Center
02	Cryogenic	23	Hazardous Material	81	Katharine Blodgett Gebbie Lab
02A	Cryogenic Annex "A"	23A	Hazardous Materials Annex	91	Construction Research
03	Liquifier	24	Plasma Physics	111	Building 4 Annex
03A	Liquifier Annex "A"	25	Maintenance Shop	112	Butler Building
04	Camco	25M1	Building 25 Annex	131	Office Trailer
05	Camco Annex	26	Day Care Facility		
08	Cryogenic Mesa Test	27	High Frequency Field		

Exhibit 2: Master Plan

- A plan that respects its location, historic context and agreements with the local community and Native American tribes;
- A plan that encourages collaboration and interaction among the laboratories and researchers, with welcoming facilities and staff amenities;
- A plan that that accommodates interchange with the public and outside colleagues, using both conference facilities and technology;
- A plan that creates an attractive campus, respecting both the research and the researchers;
- A plan that promotes good stewardship of the natural environment, and supports and advances the sustainable design goals of the Department of Commerce, GSA, NIST and NOAA;
- A plan for gradual change, that is complete at each step.

1.2 Master Plan Summary: Highlights

The Master Plan provides for the replacement of aging, inefficient buildings and accommodates modest growth in research programs over the next twenty years. Approximately 318,900 gross square feet of new facilities would be added, and approximately 153,500 gross square feet of aging and temporary buildings removed. The Plan offers a framework for accomplishing DoC's goals of creating an attractive and organized campus with appropriate research facilities. It emphasizes state-of-the-art facilities, collaboration, employee amenities, and sustainable practices.

Developed by exploring and evaluating alternatives, the Master Plan creates a new campus green as a focal point, anchored by a pedestrian pathway that links the existing and new buildings. Research buildings would be easily linked, and employees would have greater opportunities for collaboration and

Exhibit 3: Master Plan Summary

	Existing	Master Plan			
		Added	Removed	Total	Difference
Personnel					
NIST	743	112	0	855	112
NTIA	70	40	0	110	40
NOAA	939	60	0	999	60
GSA	9	0	0	9	0
Total	**1761**	**212**	**0**	**1973**	**212**
Space, GSF					
NIST/NTIA	882,174	242,097	(128,226)	996,002	113,828
NOAA/GSA	372,000*	32,600	0	404,600	32,600
Shared	incl. above	26,800	(7,776)**	19,024	19,024
Total	**1,254,174**	**301,497**	**(136,045)**	**1,419,626**	**165,452**

* NOAA now reports 415.973 GSF as existing, because of changed measurement methodology: see Program section.
**Additional shared space is removed from existing buildings, allowing renovation for other functions.
Note: MOA permitted additional space is 198,241 GSF; see Program section.

informal interaction. The improved campus setting would enhance the working environment, encourage employee interaction, and provide an enhanced sense of place and pride in the institution. Highlights are as follows:

- **Welcoming entry.** New circulation, signage and visitor parking configuration welcomes visitors and streamlines the vehicle screening process.
- **Cohesive Campus Identity.** Buildings and landscaping are coordinated to create a unified and attractive campus, complementing the stunning natural setting and replacing scattered small buildings. Linear green space is a central organizing element, with the road removed from the heart of the campus to create people-friendly connections.
- **Modest Growth.** Laboratory space needs remain relatively stable throughout the planning period, although programs and projects will adapt to DoC missions.
- **Advanced Research Facilities.** Renovation and replacement of aging and obsolete research buildings provide the controlled environments necessary for advanced measurement science and research.
- **Conference Center Enhancement.** A new Building 1 entry pavilion, added support and visitor friendly parking ease the complexity and security burden of hosting conferences and public forums.
- **Consolidated Support Facilities.** Ten buildings are replaced with a single facility that houses administrative offices, facility offices, shops, garages and storage.
- **Campus Center.** Now-scattered employee amenities and services are consolidated in a renovated Building 24, for more efficiency and opportunities for collaboration.
- **Connected Laboratories.** New laboratory buildings are arranged in a linear array that links to existing labs and supports new connections, for better efficiency, collaboration and sharing of equipment.
- **Historic Preservation.** Building 1 has been determined eligible for listing in the National Register of Historic Places. Future modifications and changes will be governed by the National Historic Preservation Act, and in accord with the Secretary of the Interior's Standards for the Treatment of Historic Properties.
- **Natural and Sustainable Campus.** The Plan emphasizes natural and sustainable landscapes, introducing native and adapted vegetation for easy maintenance, a coordinated stormwater management strategy and the creation of landscaped seating and recreation areas.
- **Energy Conservation Emphasis.** The renovations and new facilities replace multiple aging mechanical systems and package units with modern energy efficient systems, supplemented by on-site solar panels. The consolidated support facility and childcare center have net-zero energy use as a goal.
- **Structured parking.** A structured parking facility is introduced to support the new lab buildings and reduce the impervious surfaces on campus.
- **Open Space Preservation.** The Plan maintains the campus open space in a natural state, and preserves the community use trails and bicycle paths. New buildings do not interrupt views to the Flatirons.
- **Flexible, incremental growth.** The Plan allows facilities to be added incrementally, as needed and financed when federal funding permits, each being linked to an established circulation and utility network.

1.3 The Master Plan

The core concept for the Master Plan is a linear arrangement of connected laboratory buildings, facing onto a campus green, creating opportunities for collaboration, sharing resources and easy pedestrian connections. Research buildings are renovated or replaced to provide the state-of-the-art infrastructure necessary for advanced research. Collaboration and efficiency are encouraged by creating a campus center that consolidates employee services and amenities into one building. Scattered, small support buildings also are consolidated into one management office and support building, replacing ageing and temporary buildings for better operations and more efficient energy use.

The Master Plan evolved from studies of existing conditions, site and regional analyses, building evaluations and program needs. Aging buildings and infrastructure were key drivers. They can no longer economically meet research program and federally mandated directives. Many of the buildings are in poor physical condition, and temporary buildings and trailers continue to be used for critical research and support functions.

Exhibit 4: Concept—View Looking West

Key Master Plan Components

Research Buildings: Renovated

The Radio Building (Building 1), is the core research building from the initial 1954 campus construction, and remains an iconic campus building. Although its systems are outdated and obsolete, the Building 1 laboratories are valued by the research community for their spatial and structural characteristics. The labs are typically high-bay spaces and single-story on-grade, which reduces vibration transmission to research instruments. It has been undergoing a gradual renovation and upgrade program, to replace mechanical systems and meet performance levels required by NIST's evolving research, as well as federal mandates for energy reduction, seismic strengthening and physical security. Two of the building's six wings have been renovated, and there are plans to renovate the other wings and the central spine. To-date, projects have involved complete interior renovation, system replacement, recladding, addition of utility galley space, and structural upgrades to meet seismic requirements of today's building code. Future phases of the Building 1 renovation will be implemented in accordance with the National Historic Preservation Act. The Liquefier Building (Building 3) is a second laboratory building to be renovated. The project to expand and renovate this building for CTL laboratory use is underway.

Research Buildings: Replaced

Three NIST laboratory buildings, Buildings 2, 2A and lab space in 24, will be replaced. Both Buildings 2 and 24 are aging facilities (1951 and 1967), each with several additions, functional problems and systems well past their useful lives. Building 2A is a 27-year old "temporary" modular building. New research buildings are the heart of the Master Plan concept, linking new facilities to the old and shaping the central green space. The new laboratories will provide the flexibility, infrastructure and controlled environments needed to support advanced research. Laboratories for NOAA's National Weather Service will replace the Observatory Building 34 function with a new or expanded building.

Research Buildings: Retained

The David Skaggs Research Center (1999), housing NOAA, and the Katharine Blodgett Gebbie Laboratory (2012), housing NIST advanced laboratories, represent more than 50% of the campus space. These two buildings are in excellent condition and continue to support the functions within them. Other smaller specialty research buildings, such as the Hydrogen Test Facility, will remain in operation to support specific programs.

Management Resources Center: Replaced

NIST administrative functions—facility and construction management, maintenance, contracting, IT support and safety

Exhibit 5: Concept—View from Broadway

operations—are all located in separate small buildings, seven in all. An additional three buildings house the maintenance shops and support facilities supervised by this group. The existing buildings themselves are not in good physical condition; eight of the ten are temporary buildings or trailers, the oldest two from 1951. Each of these buildings has its own utilities and package mechanical equipment. Consolidation in one building will result in better energy efficiency, more efficient service for the campus, and easy opportunities for coordination and sharing of resources and equipment. The building is proposed to be a net-zero energy facility.

Campus Center: Renovated

As an adaptive reuse of a laboratory building, Building 24 will be renovated to serve as a campus center for employee services and amenities. Although shared by all campus agencies, these functions currently are located on different floors, in different buildings, and include two fitness centers and two cafeteria spaces. In addition to providing better access for all, co-location creates a gathering spot that will encourage and provide the forum for interaction and collaboration. The existing amenity spaces in Building 1 and 33 will then be available for research programs. Planned components include the fitness center, cafeteria, health center, various services desks, media/meeting rooms and informal collaboration spaces. The Campus Center is proposed to meet LEED Gold as a minimum certification.

Conference Center and Public Zone: New

Modifications to visitor screening and parking, plus a new entry pavilion, are designed to allow better use of the primary campus conference center for outside conferences and public forums. A public zone is to be established near the campus entrance and at the front of Building 1, where visitors can park their cars and walk to the conference center for security screening. A new entrance pavilion will accommodate security badging, exhibits and other staff and support facilities for the Conference Center. Redirected circulation at the entrance will create this separate parking area and improve the screening process for other vehicles.

Childcare Center: Replaced

A new building will replace the existing Childcare Center and is proposed to be a net-zero energy facility. It is planned for the current enrollment but sized to meet the GSA Childcare Center guidelines. The current facility is very cramped and consists of two conjoined modular buildings, now in poor condition.

Buildings Removed

The replacement of the laboratory buildings and the consolidation of the management/support functions permit the removal of sixteen small, obsolete and/or temporary buildings. The largest of these is Building 2 with its three additions at approximately 70,000 gross square feet, and the smallest is 525 square feet. Ten of these buildings are less than 5,000 gross square feet.

Landscape and Open Space

One of the great assets of the DoC campus is the stunning backdrop of the Flatirons and the Rocky Mountain foothills. The Master Plan embraces the best aspects of this place, visually integrating the campus into its setting, and also reducing some of the most time and resource intensive maintenance.

The signature landscape element is the linear campus green and pedestrian promenade, a unifying gesture that both connects the buildings and creates a range of social spaces and green

infrastructure integrated into the physical design. The campus green provides a coherent link across campus: the continuity of paved surface, the expressive quality of trees and ground-layer plantings, and consistent palette of paving and furniture provide thematic links across the site. A tree-covered plaza is a focal point at the center of the green, visually and physically connecting the new research buildings with the Campus Center.

Stormwater management is integrated into the design with a vegetated arroyo that parallels the central pedestrian promenade. The arroyo functions as an attractive, character-defining feature that also channels, slows, and filters stormwater off buildings and roads, which currently sheet flows across lawn and parking lots.

The proposed planting approach is modeled after the surrounding Ponderosa Pine savannah, an attractive, resilient plant community of scattered pines and cedars under planted with golden grasses. The Master Plan envisions replacing much of the water-intensive lawns that currently surround campus buildings with low grasses and clustered evergreens characteristic of savannah vegetation. Treatment will vary in different areas of the campus, as a gradient between natural and cultivated zones. Areas closer to the buildings and gathering places will incorporate more ornamental native selections. The public and conference center entrance will be the most formal landscape with structured and ornamental plantings.

Utility Framework

The Central Utility Plant (CUP) provides chilled water, steam and compressed air to most of NIST's laboratory buildings, distributed through a tunnel system running from the CUP to mid-Building 1, with services branching off the individual buildings. These systems are in good condition, and will be extended to the new and renovated NIST laboratory buildings in the Master Plan. The existing central plant has the capacity to support the proposed buildings, assuming that the new buildings will incorporate efficient HVAC systems and sustainable features, such as exhaust energy recovery, decoupled ventilation/cooling etc. Other considerations include installation of solar collection systems. The present electrical capacity also is adequate for the Plan, with two medium voltage feeders. However, the existing medium voltage high-speed transfer switch is antiquated and the manufacturer's hardware maintenance and support will soon be discontinued. The switch must be replaced. The NOAA expansion will be supported by independent systems.

Both the domestic water and sewer systems are approximately 50% loaded today, and adequate for the proposed changes. A major challenge is the significant reduction in water use required in 2020 by federal regulation, specifically Executive Order 13693.

Circulation and Parking

The Master Plan makes two major circulation-related proposals. The central campus roadway will be removed for the creation of a pedestrian-oriented and unifying campus green. A wide walkway will extend the entire length of the central campus, which will be designed to accommodate emergency and occasional maintenance vehicles when necessary. The second initiative is the modification of the campus entry, vehicle screening and visitor parking. This will support the conference center and public zone, and will also correct operational problems of the screening procedure for cars and trucks. In addition, bike paths and pedestrian trails in the Open Space are maintained.

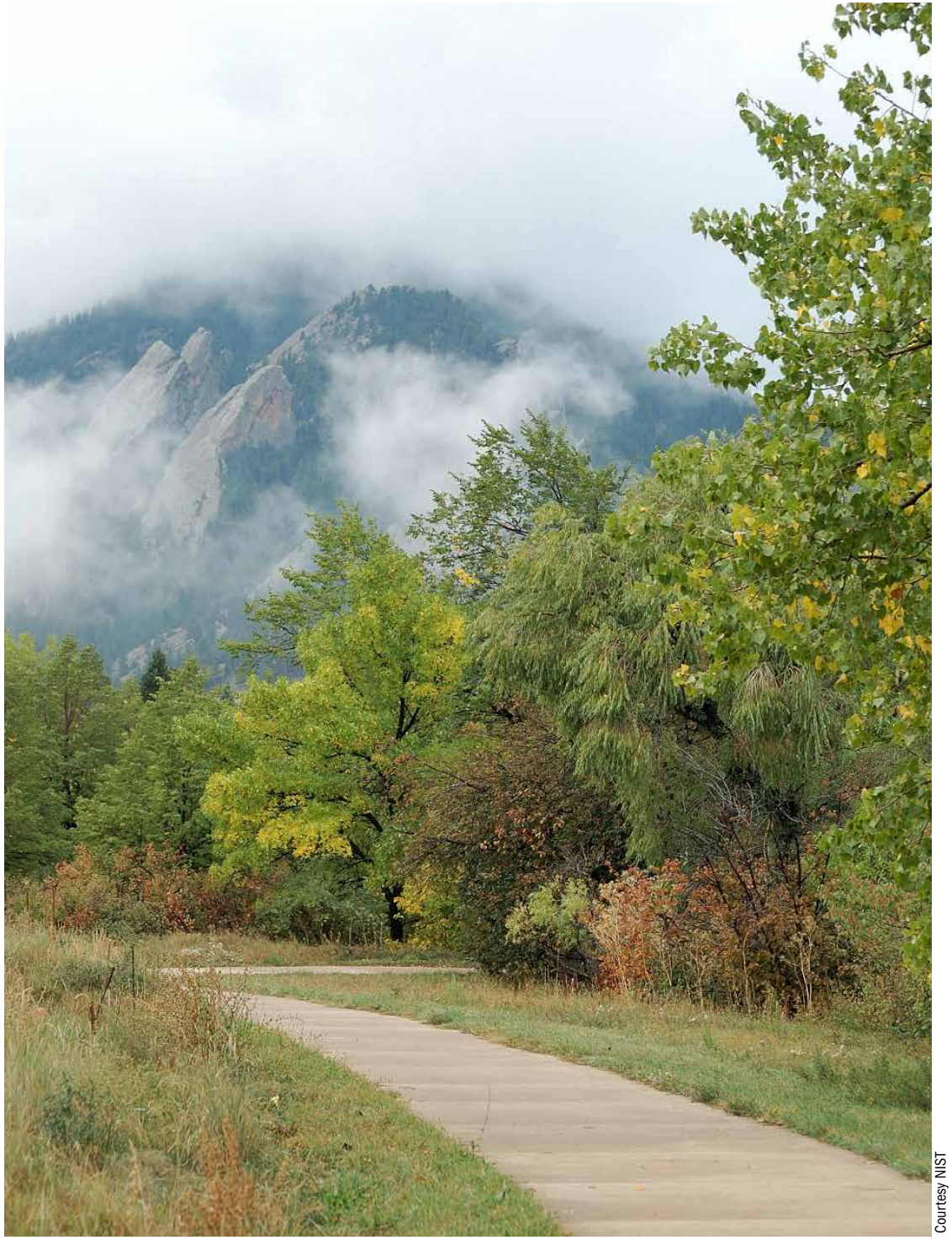
Parking demand on the campus is not expected to increase significantly, but the desired locations may shift with the building construction. Currently, there are 1,430 parking places on the campus, and that will increase modestly over the 20-year period, remaining below the maximum under agreement with the City. On-campus parking will be provided in existing surface parking lots, proposed lots near new buildings and a proposed two or three-level parking structure associated with new research building construction. The new parking structure is anticipated to be the primary parking for the new research buildings, located less than a 5-minute walk away from each.

Sustainable Design Initiatives

Sustainable design and energy efficacy are core principles, both as responsible practice and meeting the requirements of the Department of Commerce and NIST. A broad range of strategies are incorporated—water conservation, energy efficacy, adaptive reuse, stormwater management, landscape stewardship and renewable energy. Highlights include significant improved energy efficiency with the Plan's implementation, consolidating and replacing aging obsolete mechanical systems with modern ones. More buildings will be connected to the CUP for services. Stormwater management will be enhanced by the reduction in impermeable surfaces and the installation of a vegetated arroyo in the campus green. Solar collection is recommended on the Management Resources Center roof, and

Exhibit 6: Master Plan Program Summary

	20-year Growth Needs A	Facility Needs B	Master Plan Proposed Facilities A + B	New GSF	Renovated GSF	Removed GSF
Research Facilities						
NIST/NTIA	+134 people +25,400 ASF	Obsolete labs, infrastructure in B1, B2, B2A, B24 Temporary buildings 1C, 1D Underutilized/obsolete B3	Renovation in B1 (Wings 4, 5, Spine, 1, 2) Repurpose/expansion B3 New Lab Buildings Lab addition B3 Demolition of B2, 2A, 1C, and 1D	14,000 25,597 125,000 17,500	192,000 17,403	 (80,718)
NOAA	+ 60 people +21,000 ASF	Underutilized B34	Renovation/expansion B34	32,600		
Admin/Support						
NIST/NTIA	+18 people +1,600 ASF	Scattered MR administration & support in 12 buildings Aging, inefficient and temporary buildings Shipping container storage Computer Center in trailer	New Management Resource Center Demolition of 10 buildings	60,000		 (47,551)
Office of Security	+ 600 ASF				600	
Shared Facilities						
Campus-wide	+16,400 ASF	Aging Childcare Center, below current standards Scattered, limited employee services Visitor screening congestion	New Childcare Center Renovate B24 for Campus Center New Visitor Pavilion Expansion of B51 Security Center	13,000 3,000 10,000 800	 32,723	(7,776)
	65,000 ASF					
			Total growth + facility need, GSF	**301,497**	**242,726**	**(136,045)**



Courtesy NIST

Childcare Center roof, as well as other technologies to assist in achieving net-zero energy use for these buildings. PV solar arrays are also proposed for the parking structure and on a surface field west of the Warehouse.

Master Plan Implementation

The Master Plan is a look into the future—a structured approach to building and renovation that meets anticipated needs. The Plan for the Boulder campus is driven by current physical and functional needs, with research program growth integrated as a modest contributor. So although twenty years is the timeframe for this Plan's implementation, the proposed changes could have an immediate operational impact. There are five phasing packages, largely independent of each other. The Master Plan is designed to accept these packages in any desired order, and to appear "complete" at the end of each.

Master Plan implementation is dependent on many factors, such as funding, direction of scientific research, agency missions and priorities. The Master Plan needs to be thought of as a living document, setting a framework that remains flexible and sensitive to the timing and composition of specific projects.

Exhibit 7: Fast Facts

	2016	20-Year Target
Personnel	1,761	1,973
Buildings	29	19
Square Footage-total	1,254,174 GSF	1,419,626 GSF
Parking	1,430 spaces	1,525 spaces
Impervious Area	51.5 acres	49 acres
Alternative Energy	–	Building solar, Solar field

Exhibit 8: Phasing Packages

Phasing Packages	Major Components	Comments
NIST Research Buildings	Building 1 Renovations Building 3 Repurposing	Multi-step process to ensure research continuity
	New Research Buildings, replacing Building 2, 2A & 24 labs Demolition of Buildings 2, 2A Creation of Campus Green, center section Road/parking modifications; partial removal of center road New Parking Garage	
Campus Center	Renovation of Building 24 Covered connection to new research buildings Pedestrian, parking modifications	Follows or is combined with New Research Buildings
Visitor Center, Parking and Vehicle Screening	New visitor pavilion at Building 1 Conference center renovation; loading dock relocation Parking lot modification Roadway and vehicle screening modifications Addition to Building 51	Independent package; could proceed at any time May be advantage to combine B1 visitor pavilion with other B1 construction.
Management Resources Center	New Management Resources Center Swing space for Building 4, 5 occupants Demolition/removal of 10 support buildings Roadway, parking, utility yard modifications Installation of solar collection field	Independent package; could proceed at any time. Completion would free up some space in B1
NOAA Research Building	New research building or expansion of Building 34 Roadway, parking modifications Road/truck maneuvering expansion at Building 22	Independent package; could proceed at any time
Childcare Center	New Childcare Center, replacing existing Building 26 Landscaped play areas Removal of remainder of center road & relocation Completion of Campus Green	Independent package; could proceed at any time. Must be completed if/when future lab buildings are desired.

Campus View from the Mesa

2 Background

2.1 History of Campus Development

The existing campus of the Department of Commerce (DoC) at Boulder was purchased by the Boulder Chamber of Commerce and its citizens in 1950 and donated to the Department of Commerce to house the National Bureau of Standards (NBS), which was renamed the National Institute of Standards and Technology (NIST) in 1988. The site was considered ideal for the measurement science and research that NIST conducted, and its close proximity to University of Colorado promised outstanding scientific resources.

In its first 10 years on this site, NBS constructed over 300,000 gross square feet of space including the Radio Building 1 which included the library, auditorium, center spine and 5 wings (the sixth wing was built in 1962), the Cryogenics Building 2, the Liquefier Building 3, the Camco and Heavy Equipment Buildings 4 and 5, and several small structures.

Between 1960 and 1970, another 140,000 gross square feet was constructed, mostly in additions to existing Buildings 1 and 2, plus the construction of the Plasma Physics Building 24 and Warehouse Building 22. The next 30 years in the history of the Boulder campus can be termed as the era of temporary structures. Numerous small buildings including the Childcare Center, Building 26, the Hazardous Materials Building 23, and annexes to Buildings 1, 2, 4, 24, and 25 were added. The additional square footage added to the NIST building inventory over 30 years was about 53,000 gross square feet.

By 1990, NIST had recognized that its laboratory buildings, which were over 35 years old, were becoming obsolete and deficient for contemporary research and science. In 1991 NIST published its Capital Improvement Facilities Plan (CIFP), which documented the severe technical obsolescence and deteriorating facility conditions. A needs assessment found that about 60% of Boulder Laboratories failed to meet performance standards required by then current scientific and engineering programs. The study recommended construction of a Central Utility Plant (CUP), a clean room building, construction of new laboratories and a workshop—projecting a need for 372,000 gsf of new construction. It also recommended renovation of 4 wings (3, 4, 5 and 6) of Building 1 and minor renovation of Building 4.

Concurrently, DoC began considering consolidation of the National Oceanic and Atmospheric Administration (NOAA) facilities on campus as well as a facility for the U.S. Forest Service. Requirements for the two agencies were developed by General Services Administration (GSA), who was charged with accommodating them on campus. The planned development on the site faced significant opposition from the public and the Boulder City Council. As a result, NIST undertook to prepare a Master Site Development Plan that would set a framework for future development established through cooperative efforts of the City of Boulder and the Department of Commerce. The Forest Service facility was removed from the development plan.

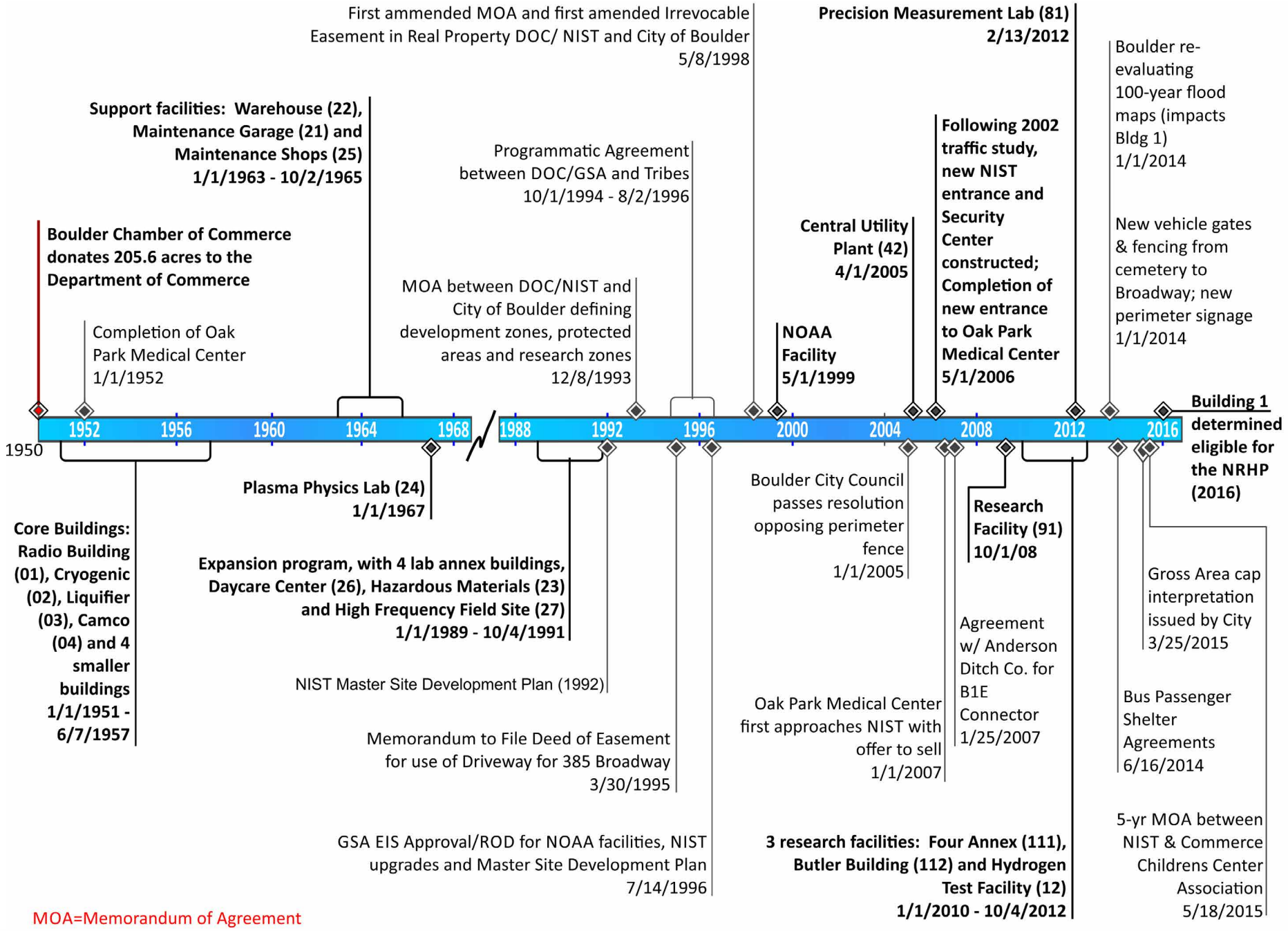
After the approval of the 1992 Master Site Development Plan, the Central Utility Plant (CUP), the Katharine Blodgett Gebbie Laboratory, the David Skaggs Research Center for NOAA, and the Security Center were built. The NOAA building was completed in 1999; the CUP and Security Center were built in 2005; and the Gebbie Laboratory was completed in 2012. The existing DoC Campus now has 29 buildings, many of them small, totaling approximately 1.25 million gross square feet.

2.2 Previous Master Plans & Studies

In its 65 years of existence the campus has grown over four times from its initial 286,000 gross square feet in 1954 to about 1.25 million gross square feet. About 70% of the overall facility inventory, or about 882,000 gross square feet is occupied primarily by NIST. While various studies have been conducted over the years, a comprehensive master plan was never developed for the DoC Boulder Campus site. The following provides a chronological list of the key studies and plans prepared for the campus.

- 1963 *Campus Development Plan*: James M. Hunter and Associates developed a long range plan for the National Bureau of Standards for developing new and expanded facilities. The plan forecasted a four- fold increase over the next 20-30 years before levelling off. The campus population would increase to 6,000–7,000 staff. It recommended a central core with administration and central support functions; an inner ring of intensive labs and offices; and, an outer ring of less intensive uses. The mesa was recommended for preservation, for an appropriate semi-independent use.
- February 1992 NIST *Master Site Development Plan*: Smith, Hinchman & Grylls Associates, Inc. developed this plan to address DoC's short and long range development needs and possibilities at the Boulder site. It identified a need to increase the 490,000 GSF of NIST facilities that existed by 697,000 GSF to include expanded facilities for NIST and new facilities for NOAA. A substantial increase in site parking spaces was also recommended, with the potential for 1,330 spaces. The final plan proposed maximizing infill zones within the existing NIST development and adding 9.22 acres for NIST and 12.9 acres for NOAA. Overall, development would comprise a total of about 80 acres, or 38.7% of the Site.
- March 1993 *Cultural Resource Inspection of the Proposed Building Site for* NOAA: Prepared by the National Park Service's Interagency Archeological Services in conjunction with the planning for the new NOAA facilities, the survey was conducted over the 55 acre project area. The historic Anderson Ditch was identified as the only asset eligible for the National Register of Historic Places, as it represented early irrigation efforts in Boulder County. It recommended that the Anderson Ditch be documented in some detail and avoided by construction.
- June 1996 EIS *for Actions by* GSA *for the* NOAA *and* NIST *in Boulder, Colorado*: The EIS investigated three primary proposed actions: consolidation of NOAA Facilities; upgrades to NIST Facilities; and, implementation of the NIST Master Site Development Plan. Besides the No Action Alternative, the EIS considered development alternatives at the DoC Campus, the IBM Plant Site in Boulder, and the CU-Boulder Research Park. When measured against the criteria identified by NIST and GSA/NOAA, no site other than the DoC Campus met all criteria. There were three areas of controversy: the size and location of the proposed GSA/NOAA building; allegations that a traditional cultural property, possibly a Native American medicine wheel, was located on the DoC campus; and, regional traffic might overburden several intersections in the general area of the preferred site. Development on the DoC Campus was the preferred alternative. Potential environmental impacts and appropriate mitigation measures were identified.
- July 2002 NIST *Main Entrance Study*: This study was conducted by Entranco, Inc. to investigate potential modifications to secure the campus in the wake of the September 11th, 2001 terrorist attacks. The study notes that the federal regulations require a single entrance be maintained to all federal facilities such as the campus. The Boulder campus had two: the main entrance from the Broadway and 27th Way intersection; and, a secondary access from Broadway at Rayleigh Road. After reviewing multiple alternatives, NIST decided to relocate its main campus access to Rayleigh Road and modify the Broadway access at 27th Way to provide an exclusive access to the medical center property to the north. The issue of traffic conflict between vehicles and bicycles/pedestrians at the NIST entrance was discussed. It was determined that ideally a grade-separation at the main entrance to NIST would provide NIST traffic and bicycle/pedestrian traffic with an improved safety condition.
- January 2006 *Report on* NIST-*Boulder Laboratory Facilities*: The NIST director convened a Boulder Facilities Team to review the amount and performance of laboratory space in the campus in consultation with technical staff and Division leadership. This report summarized the team's findings and recommendations. It found that NIST-Boulder metrology and research programs would not expand but evolve to meet changing needs and address new technologies. A significant majority of the labs were found to be inadequate in performance. The report identified a need for 130,000 net

Exhibit 9: History of Campus Planning and Development



MOA=Memorandum of Agreement

assignable square feet (nasf) of good quality lab space and 48,000 nasf of metrology quality lab space with additional clean room space. Renovation of existing lab space and construction of a new advanced technology lab was recommended (now the Katharine Blodgett Gebbie Laboratory). A need for additional studies by a subject matter expert was also recommended to accurately determine laboratory facility needs and estimated costs, for renovation and new construction, revising the report's estimates as necessary.

- October 2014 *Safety Study for Broadway Street & Rayleigh Road*: NIST contracted Alfred Benesch & Company to study the intersection of Broadway and Rayleigh Road, the main entrance to the campus. The study was conducted as a result of bicycle/vehicle crashes at that location and several near misses. The study offered solutions based on signalizing; the eastbound right-turn movement; bicycle traffic calming; intersection reconfiguration; and crossing relocation.
- August 2015 *Program and Performance Requirements for the Reuse and Repurposing of Building 3*: The study established the space requirements for the CTL lab components in the expanded Building 3, to be provided to the design-build contractor. Technical room requirements and building system performance requirements were included.
- July 2016 *Historic Assessment, Department of Commerce Boulder Laboratories*: This was a comprehensive study of the history and development of the DoC campus, and an evaluation of resource significance and integrity. See Chapter 14 for a study summary.

2.3 Agreements

During the early planning stages for the NOAA facility in the 1990s, the Department of Commerce and GSA worked closely with the City of Boulder to address community concerns regarding further development on the site. The following agreements were signed, which considerably shaped future site development.

- April 1995 *Programmatic Agreement with the Tribes*: This agreement was extended to the Medicine Wheel Coalition and federally recognized Native American Tribes as a result of a consultation process. An irrevocable easement was established that overlapped with an existing irrevocable easement on the site held by the City of Boulder, a signatory to the agreement. The agreement includes provisions for use, management, maintenance, and other minor conditions. The City of Boulder Open Space retained the responsibility of maintaining the space.
- May 1998 *First Amended Irrevocable Easement in Real Property*. This agreement between the City of Boulder, Department of Commerce and NIST grants the City an easement to establish the open space protected area on DoC property, and defines boundaries, conditions for its use and maintenance. This updates a previous agreement signed in 1993.
- May 1998 *First Amended* MOA *between* NIST, US DoC, *and the City of Boulder*: This agreement updated a previous MOA signed on December 8, 1993. This updated MOA addresses DoC's and NIST's present and future federal research needs and the City's interests in preserving part of the undeveloped space and providing public access and enjoyment. Development zones, research zones and protected areas and their extents are defined in the agreement and restrictions noted. Other provisions of the agreement address traffic management, utilities, environmental considerations, and future construction considerations.
- Several other agreements are in effect, including:
  - 385 Broadway Easement: A deed of easement granting a vehicle right-of-way from Broadway through DoC property to the Medical Center 385 Broadway; dated April 4, 1995.
  - Regional Transit District; A license granting permission for bus stops on DoC property along Broadway at 27th Way and Ash Street; dated June 16, 2014. The agreement is in effect for 5 years.
  - Anderson Ditch: DoC owns some shares in the Ditch, and has an agreement with the Anderson Ditch Company for easement through the DoC property, rights for irrigation use and NIST responsibility for repair and maintenance of the Ditch section on DoC property; latest agreement update 2007.
  - Childcare Center: A Memorandum of Understanding for the *Establishment of an On-Site Child Care Facility*, between the Boulder Laboratories and the Commerce Children's Center Association. Under the agreement, Boulder Laboratories is to provide space and facility services.
  - Utilities: An agreement with the City of Boulder for installation, operation and maintenance of utility and communications lines, dated February 2000.

Exhibit 10: Building Construction History

2.4 Agencies on Campus and Their Relationships

National Institute of Standards and Technology (NIST)

NIST was founded in 1901, as a non-regulatory federal agency within the U.S. Department of Commerce. It promotes U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve the quality of life.

The NIST Laboratories conduct world-class research, often in close collaboration with industry, to advance the nation's technology infrastructure and help U.S. companies continually improve products and services. Approximately 20% of NIST's Laboratory Programs are located in the DoC Boulder Campus. NIST's research in Boulder includes Microfabrication and Characterization; Laser and Optoelectronics; Time and Frequency Metrology; Quantum Information and Communications; Electromagnetics; Materials Properties; and, Chemical Properties.

NIST's laboratories on the Boulder campus are concentrated in five major buildings: Building 1, Building 2, Building 3, Building 24 and Building 81. NIST also manages all of the remaining buildings except for Buildings 33 and 34, which are occupied by NOAA and managed by GSA.

National Telecommunications and Information Administration (NTIA)

The National Telecommunications and Information Administration (NTIA) is a bureau within the Department of Commerce's Executive Branch and is principally responsible for advising the President on telecommunications and information policy issues. Its primary focus is expanding broadband internet access and adoption, expanding the use of spectrum by all users, and ensuring that the internet remains an engine for continued innovation and economic growth.

NTIA's research and engineering arm, the Institute for Telecommunication Sciences (ITS), is located on the DoC Boulder Laboratories Campus. ITS provides telecommunications research and engineering services to promote enhanced domestic competition and new technology deployment; advanced telecommunications and information services; improved

Exhibit 11: NIST Table of Organization

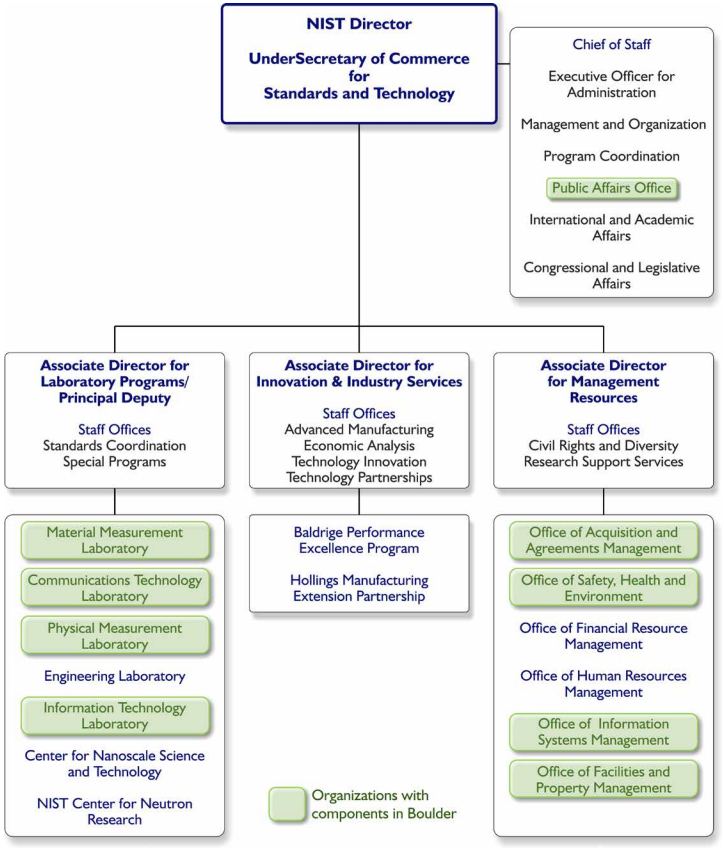
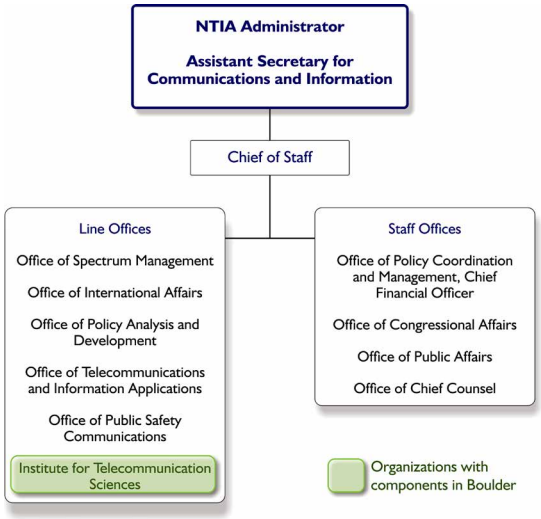


Exhibit 12: NTIA Table of Organization



foreign trade opportunities for U.S. telecommunication firms; and, more efficient use of the radio frequency spectrum.

ITS is located within NIST buildings, and many of its organizational units work closely with NIST's Communications Technology Laboratory (CTL). Its work at Boulder focuses on promoting and managing the radio spectrum and improving emergency responder communications.

National Oceanic and Atmospheric Administration (NOAA)

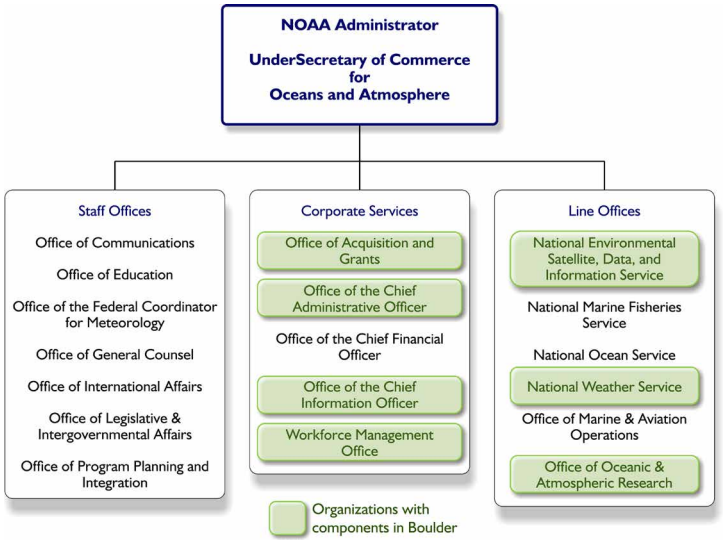
NOAA's roots date back to 1807, when the Nation's first scientific agency, the Survey of the Coast, was established. Today, it maintains a presence in every state and has emerged as an international leader on scientific and environmental matters, playing a role in protecting life and property and conserving and protecting natural resources.

At Boulder, NOAA's work is rooted in the Central Radio Propagation Laboratory (CRPL) which was founded in the 1950s to conduct research on atmospheric processes and solar impacts. Currently, there are three major NOAA components at the Boulder facility: Office of Oceanic and Atmospheric Research; National Weather Service; and National Environmental Satellite Data and Information Service.

The Office of Oceanic and Atmospheric Research is a key research component of NOAA, studying the complex planetary systems for a better understanding of the earth, better forecasts and earlier warnings for natural disasters. The Earth System Research Laboratory is NOAA's largest laboratory where researchers study the dynamics of the earth's physical, chemical and biological systems work together to produce weather and influence ecosystems.

The National Weather Service provides climate and weather information, including historical data, forecasts and warnings. The Denver-Boulder Forecast Office is one of the many local stations across the country, providing forecasts for the Eastern Colorado. NOAA's Space Weather Prediction Center monitors solar activity, issuing information and warnings of space weather that can affect power grids, navigation, communication and other critical systems. It is a unique facility that provides real time space weather data to users across the planet.

Exhibit 13: NOAA Table of Organization



The National Environmental Satellite Data and Information Service monitors and researches global environmental information from satellites, with its National Centers for Environmental Information located on the Boulder campus. The resulting data supports the management of environmental resources and the operations of aircraft and ships. The Paleoclimatology Program archives and studies past climate data to assist in the prediction of natural variations and future climate change.

NOAA's Boulder components are located in the David Skaggs Research Center (Building 33) and the Solar Observatory (Building 34). The two buildings, the associated parking areas and the grounds immediately adjacent (totaling about 15 acres), are managed by General Services Administration (GSA).

Campus Management and Campus Cross Services Agreement

NIST, NTIA and NOAA have a standing cross services agreement to cover several campus related functions.

NIST, with the DoC Office of Security (OSY), is responsible for the overall campus security and visitor screening. OSY is responsible for the campus policing services as well as visitor screening. NIST is responsible for access controls. The security

of Buildings 33 and 34 that house NOAA components and the grounds that are immediately adjacent to those buildings and their parking lots are the responsibility of Federal Protective Service (FPS). However, FPS does not have a station on site and responds to calls as needed. OSY provides first response for GSA managed facilities as a courtesy. Boulder City Police provides back-up to the DoC campus police, although there is no formal mutual support agreement.

NIST is generally responsible for the site maintenance for the entire campus except for the GSA managed area (approximately 15 acres around Buildings 33 and 34). Other NIST responsibilities in the cross services agreement include audiovisual and conference services; maintenance of the Childcare Center; site/facility health and safety; environmental compliance and management services; hazardous and regulated waste management; site emergency management; custodial; and transit subsidy. Personal property is managed by both NIST and NOAA.

NOAA currently is responsible for maintaining the Network Operations Center which manages internet connectivity for all DoC components on the campus. It is also responsible for managing the health unit; mail delivery/ pickup; freight shipping receiving and delivery pickup; store room services; warehousing; publications and printing; and library services.

NTIA/ITS manages Radio Frequency related issues on the campus.

NIST Components at the Boulder Campus

Organizational Units (OUs) are the functional groupings on campus and the building blocks for the Master Plan. Offices, laboratories and support spaces are assigned to OUs, and this Master Plan continues to use that designation. The OUs are not necessarily consolidated. Specialized facilities and laboratory types may be grouped together for shared infrastructure, and intermittent growth has separated OUs based on available space. One goal of future development is to conveniently locate those specialized spaces that may be shared by several groups.

Material Measurement Laboratory (MML)—Organizational Unit 63

MML serves as the national reference laboratory for measurements in the chemical, biological and material sciences through activities ranging from fundamental and applied research, to the development and dissemination of certified reference materials and tools to assure the quality of measurement results. MML is also responsible for coordinating the NIST-wide Standard Reference Material and Standard Reference Data programs. The Applied Chemicals and Materials Division is located in its entirety at the Boulder campus. The main research activities concentrate on the thermophysical properties of fluids and the reliability of materials. The main facilities include: mechanical testing, optical, scan-probe and electron microscopy, experimental properties of fluids (e.g. density, speed of sound, vapor-liquid equilibrium, others), synthesis and characterization of nanoparticles, microbial studies, and computational chemical and materials science.

Communications Technology Laboratory (CTL)—Organizational Unit 67

This new Laboratory at NIST, established in 2014, performs cutting edge research and development in advanced communication technologies, targeting understanding, testing and validation. CTL conducts research and development on the metrology and understanding of physical phenomena, and materials and systems relevant to advanced communications. Research areas include high-speed electronics, wireless systems metrology, antennas, advanced optics, network design and optimization, and public safety communication. CTL works with NTIA in a joint NIST/NTIA program—the Center for Advanced Communications—to provide opportunities for collaborative research and access to test-bed resources. The CTL is headquartered at the Boulder campus.

Physical Measurement Laboratory (PML)—Organizational Unit 68

PML develops and disseminates the national standards of length, mass, force and shock, acceleration, time and frequency, electricity, temperature, humidity, pressure and vacuum, liquid and gas flow, and electromagnetic, optical, microwave, acoustic, ultrasonic, and ionizing radiation. Its activities range from fundamental measurement research through provision of measurement services, standards, and data. Three PML Divisions are located on this campus—the Applied Physics Division, the Quantum Electromagnetics Division, and the Time and Frequency Division. The Applied Physics Division's key competencies include radiometry, advanced communications, sensing, imaging, quantum

measurements, signal metrology, biophotonics, spectroscopy, forensics, and laser safety. The Division operates a state-of-the-art precision imaging facility to create and characterize unique devices that improve measurement science, standards, and services. The Quantum Electromagnetics Division leads scientific breakthroughs in the measurement needs for microfabrication, and operates a state-of-the-art micro/nano-fabrication facility. The Time and Frequency Division maintains the standard for frequency and time interval for the United States, provides official time to the United States, and carries out a broad program of research and service activities in time and frequency metrology.

Information Technology Laboratory (ITL) —Organizational Unit 77

ITL supports the NIST mission through research and development in information technology, mathematics, and statistics. ITL is addressing hard problems in IT Measurement Research through development of protocols and operational standards that mitigate anticipated discrepancies in systems operation, and establishing assessment criteria and test data sets for validation of industrial products. ITL formulates metrics, tests, and tools for a wide range of subjects including information complexity and comprehension, high confidence software, space-time coordinated mobile and wireless computing, as well as, issues of information quality, integrity, and usability. Two groups of the Statistical Engineering Division are housed at the Boulder campus.

Office of Information Systems Management—Organizational Unit 18

OISM acquires and manages information technology resources across the campus, for scientific and business computing services. It has the responsibility for centralized IT functions including telecommunication, networking, web services, integrated information systems, knowledge systems, and other IT infrastructure support services. OISM provides customer services for software and hardware, and for integrating emerging technology to assist the research mission. OISM also provides security for the IT network, including oversight and training.

Office of Facilities and Property Management—Organizational Unit 19

OFPM is responsible for overall management and operations of the campus facilities, including maintenance of buildings and grounds, provision of infrastructure, renovations, and design and construction of new facilities. OFPM also coordinates with other on-site federal agencies and local regulatory agencies and organizations including the City of Boulder and Native American Tribes.

Director's Office—Organizational Unit 0

The Public Affairs Office (Division 107) is responsible for media relations and conference support on the campus. The group provides organizational, technical and logistical support for teleconferences, meetings and conferences. The AV Services personnel keep track of equipment and inventory, oversee the room reservation system and maintain AV equipment and related gear. The Conference Services personnel organize the conferences and work with the Gaithersburg Conference Services group to register attendees, collect names and necessary information for Foreign National attendees and provide support as necessary (name badges, room sets, wireless network connectivity, etc.) Public Affairs also organizes tours and demonstrations, and collects images and artifacts for display.

Associate Director for Management Resources—Organizational Unit 13

Fabrication Technology (Division 136) operates and manages production orders for a sophisticated machine shop. There are currently 2 staff members of Fabrication Technology, which is not expected to change in the next five years.

Office of Acquisition and Agreements Management—Organizational Unit 14

Acquisition Management (Division 141) supports the campus through the purchasing and management of contracts for goods and services on the Boulder campus

Office of Safety, Health and Environment—Organizational Unit 15

The mission of Boulder Safety, Health and Environment Division (Division 153) is to help reduce safety, health, and environmental risks at NIST by planning, developing and maintaining, safety compliance and continually improving NIST's safety, health and environmental programs. Disciplines include fire protection, environmental compliance, radiation safety and industrial hygiene. Research laboratories are the customers for this group.

2.5 Applicable Standards and References

The master plan will be prepared in accordance with applicable Department of Commerce and other Federal statutes. The plan will be guided by the Boulder City and County's Boulder Valley Comprehensive Plan, and related policies. Among the relevant standards and references are the following:

- First Amended Memorandum of Agreement between the National Institute of Standards and Technology, US Department of Commerce and City of Boulder; May 1998
- US Clean Water Act; US Environmental Protection Agency; 1992; and NIST Stormwater Permit #COR042002
- US Department of Commerce *Real Property Management Manual*; August 2014, revised March 2017
- DoC Departmental Administrative Order 217-21; Space Allowance and Management Program
- DoC Departmental Administrative Order 217-16; Energy and Environmental Management.
- National Environmental Policy Act (NEPA); US Environmental Protection Agency; January 1970
- NIST *Sustainable Design Manual*; July 2014
- Department of Commerce, *High Performance and Sustainable Buildings Handbook*; February 2011
- Department of Commerce *Implementation Handbook for the Strategic Sustainability Performance Plan*; August 2013
- National Historic Preservation Act of 1966, as amended; Department of the Interior, National Park Service
- *Colorado Cultural Resource Survey Manual, Guidelines for Identification: History and Archaeology*; Colorado Office of Archaeology and Historic Preservation; 2007
- US Executive Order 13693: *Planning for Federal Sustainability in the Next Decade*; 2015
- CEQ's *Guiding Principles for Sustainable Federal Buildings and Associated Instructions*; February 2016
- US Energy Independence and Security Act of 2007 (EISA 2997) US Energy Policy Act of 2005 (EPAct); 2005
- GSA P-100 Facility Standards for Public Buildings, for GSA-owned facilities

2.6 Master Planning Process

The Master Plan for the DoC Boulder Laboratories Campus has been developed in three phases. Throughout the three phases, the consultants worked closely with DoC representatives, and also interacted with the local regulatory authorities such as the City of Boulder and Colorado State Historic Preservation Office (History Colorado.)

- Phase-I of the project collected facility, site and contextual information, which was summarized in a Contextual Analysis report. A functional programming exercise projected campus requirements over 20 years. Subsequently, development concepts were developed and reviewed with the DoC Boulder Labs Master Plan Steering Committee for the selection of a preferred concept, which became the Master Plan concept. This step also included an assessment of historic and cultural campus assets and a NEPA scoping process that included a public presentation.
- Phase-II developed a Draft Master Plan Document based on the selected alternative, with related site infrastructure, circulation, landscape frameworks. A draft Environmental Assessment was also prepared.
- In Phase-III, Master Plan Document and Environmental Assessment was finalized after final review by the Steering Committee and public comments.

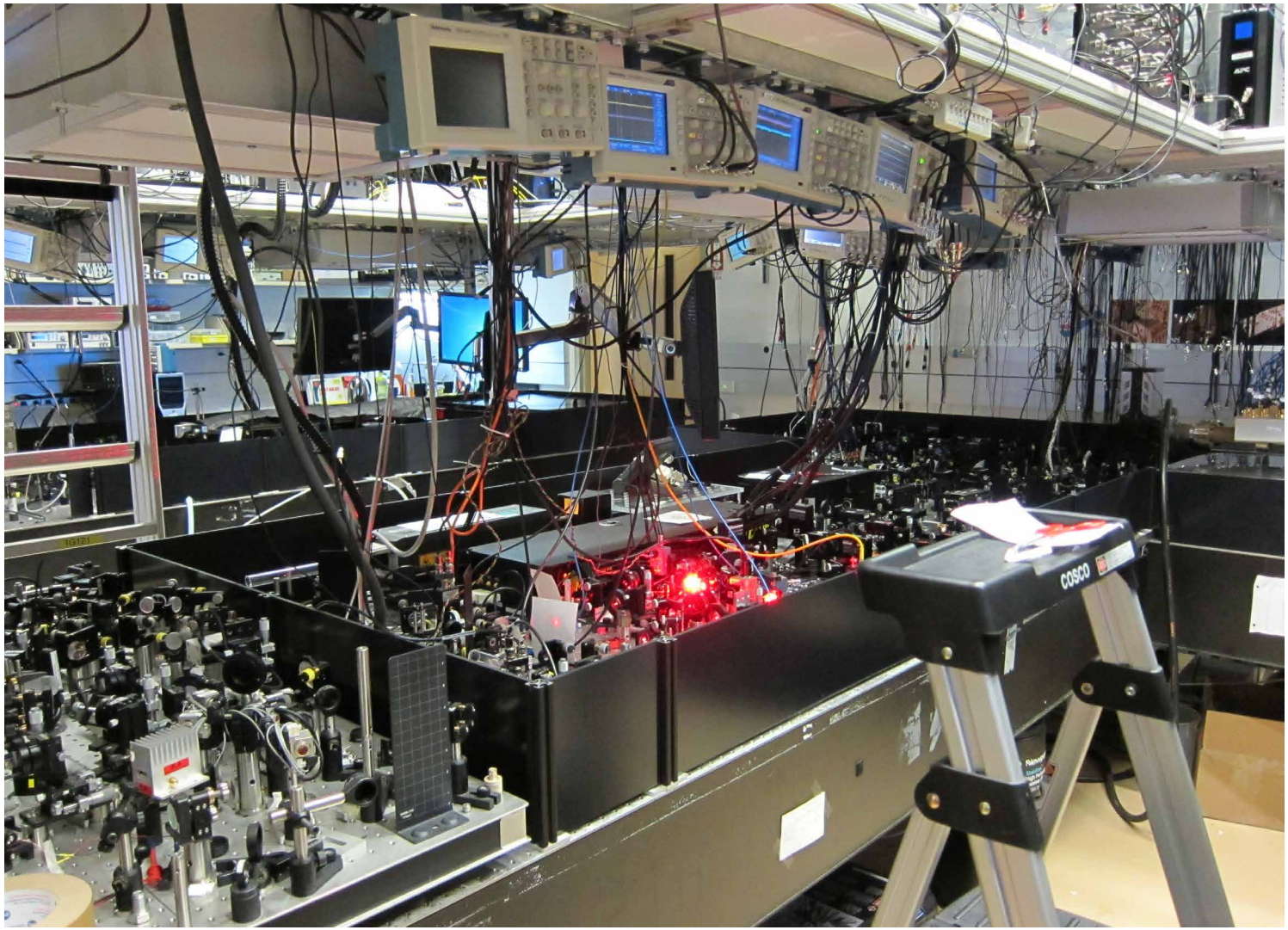
Campus User Feedback

An employee survey was conducted for the DoC Boulder Labs Campus Master Plan. The web based survey was live between July 10 and July 24, 2015 and was open to all DoC Federal employees in the Boulder Campus. A total of 246 responses were received of which 143 were from NIST, 91 from NOAA, 11 from NTIA, and 1 from a contract employee working for NIST. The following are some of the key findings from the survey:

- A large number of respondents indicated an appreciation for the natural setting and the location of the campus.
- Many respondents pointed out inadequacies in building services and infrastructure, availability of quality food and beverage service, location and quantity of parking spaces, site circulation issues, grounds and building maintenance, and constant construction.
- More than two-thirds of the responders felt that many conferences cannot be hosted on-site. The top reasons cited

were stringent site security and visitor processing requirements (especially for foreign personnel), size of the conference facilities, inadequate parking facilities, and technical deficiencies of the conference facilities.

- A little over half of the responding employees drive alone to work. Almost 18% are bicycle commuters, and 9% ride the bus. About 11% use multiple modes of transport.
- Over 60% of the respondents indicated that they use the library (the physical space or the services such as online services, inter-library loan, librarian assistance, etc.). About 8% use the childcare services.
- NIST and NTIA employees responding to the survey favored consideration of dining or casual snack/beverage services, fitness center and bicycle storage facilities in the master plan over other amenities.
- Most respondents agreed that improved fitness center, locker and shower facilities; landscape enhancements; and parking management should be considered in the master plan. They also identified that for increased collaboration, a shared expanded centralized cafeteria and expansion of conference services were most needed.



Master Plan

3 Master Plan Program

TWO components of the Department of Commerce—the National Institute of Standards and Technology (NIST) and the National Oceanographic and Atmospheric Administration (NOAA)—are the primary tenants of the campus. The National Telecommunications and Information Administration (NTIA) occupies a portion of NIST space, and the General Services Administration (GSA), as the manager of NOAA facilities, has a facilities management office in their space. With recent organizational changes, DoC Office of Security (OSY) now occupies space in NIST facilities.

The overall existing space on campus is approximately 1,254,000 gross square feet. NIST manages the majority of these buildings, including campus support and security buildings that serve all agencies, although GSA manages the NOAA buildings and surrounding area. Three buildings that house laboratories and offices account for over 75% of the overall campus space: the Radio Building (NIST), the Katharine Blodgett Gebbie Laboratory (NIST) and the David Skaggs Research Center (NOAA). As of October 2015, the population on campus was 1,776 people, including federal employees, affiliates and contractors.

Exhibit 14: Existing Personnel and Occupied Space—October 2015

	Personnel	Assignable SF
NIST	743	343,627
NTIA	70	28,452
NOAA/GSA	963	228,116
Shared	—	65,574
Total ASF	1,776	665,769
Gross Square Feet		1,254,174

The space needs of current and future DoC employees are constantly shifting, modulating with the rise and fall of research projects, changes in staff assignments, and shifts in agency priorities and budget realities. For the Master Plan, space requirements were projected based on the Department's historic patterns, current usage and goals developed for the Plan, realizing that the program components and square footages are a framework for the Master Plan and will be reviewed with each construction project. Space needs were projected for a twenty year period, with 5-10 years being the most realistic projections.

The space program for the Department of Commerce Boulder Laboratories was developed with DoC participation, and analysis of the current space use and data base information. The process included the four different agencies on the site, NIST, NTIA, NOAA and GSA. The process to understand their requirements and estimate the space necessary to accomplish their functional goals was based on the following:

- Review of DoC and NIST guidelines and policies for labs and office space
- NIST *Laboratory and Administrative Space Planning Study*, a parallel study that determined NIST's current utilization and projected future need utilizing survey forms and interviews
- NOAA-provided space information and projected needs
- Interviews with steering committee and user groups about program needs, future direction and goals
- Employee survey of amenities and campus-wide needs
- Analysis of campus buildings, their functional issues and locations.
- Consideration of the overall campus goals and integration of the various user agencies.

Personnel growth on Campus is expected to be modest over the planning period, projected to increase by approximately 11% overall during the planning period. Space growth and change is based more on the replacement of aging and inadequate facilities than on space needed for additional personnel. Many of the existing laboratory buildings do not have the infrastructure support (interstitial or galley space) needed for the advanced research taking place, and support space will be added as the buildings are replaced. In addition, administration and campus support facilities are scattered in multiple buildings, and when consolidated, space will be saved.

3.1 Space Needs for Growth and Change

The square footages on the accompanying table are shown in terms of both assignable and gross square feet. Assignable square footage is the area that is usable and assigned to specific personnel groups, such as offices and labs. For administrative space, net includes the office areas and the secondary circulation within the suites. Gross square footage covers the entire building, including the bathrooms, corridors, mechanical spaces, etc. The ratio of assignable-to-gross varies for different kinds of space; for example, lab spaces have a very high assignable-to-gross ratio because the mechanical and equipment galley space is part of the "gross". For the Master Plan, gross square footage is the building block, because it represents the entire building or addition that must be included in the plan.

The space program projections are based on assumptions and existing priorities of the Department of Commerce agencies. These projections are not definite requirements or funded projects, but provide the planners a basis to develop a framework for the Master Plan.

The following chart projects the additional space that is required to accommodate projected staff increases and anticipated growth or change in laboratory/support needs. It is limited to the incremental increase to specific spaces, and does not include space needed to modernize the existing buildings or consolidate inefficient operations.

3.2 Space Needs

Space needs are projected to be relatively stable over the coming years, with little laboratory growth beyond the planned personnel and space for the Communications Technology Laboratory for NIST, and space for NOAA's National Weather Service program. Modest administrative and support staff growth is anticipated. The Master Plan space program is based on the anticipated staff growth and planned research initiatives. New square footage is included in the following:

Personnel Space. Office and office support space is allocated based on Department of Commerce policy of assigning 170 assignable square feet per-person. This allocation covers offices, workstations and related offices areas such as conference rooms, copy centers, breakrooms, filing etc. As new and renovated space comes into use, this standard will be utilized. Specific Master Plan assumptions include:

- The administrative groups anticipate average staff growth of 7% in the next five years, plus an additional 4% over the planning horizon, based on questionnaire responses.
- Laboratories MML, PML and ITL are assumed to have a modest 5% growth in personnel over 20 years. CTL anticipates significant growth in the near term.

Laboratories and Lab Support. Lab space allocations are based on the existing lab utilization, discussions and projections from laboratory directors, as developed in the parallel NIST *Laboratory and Administrative Space Planning Study*. The assignable square footage for laboratories is anticipated to remain fairly stable, but the gross square feet will increase as facilities are replaced or renovated in order to provide the utility infrastructure necessary to support the advanced research programs. Specific Master Plan assumptions include:

- CTL anticipates growth of 70 people, and the addition of lab space, currently planned for implementation by renovating and expanding Building 3.
- NTIA expects to grow by 15 people in the near term, to a total of 110 people in the next 15-20 years. Most of their work is in the field, and additional laboratory space is not planned at this time.
- National Weather Service has not yet finalized their needs, but the planning assumption is the addition of 45 people, and 5,000 SF of laboratory space, based on initial discussion.
- MML, PML and ITL expect their lab needs to remain relatively stable over the planning period.
- Laboratory renovations and replacements are planned.

Exhibit 15: Program of Space Needs

Organization	EXISTING October 2015 Data		5-10 YEARS PROJECTIONS		20 YEAR PROJECTIONS		20 YEAR OVERALL DIFFERENCE	
	Number of People	Space ASF	Number of People	Space ASF	Number of People	Space ASF	Number of People	Space ASF
NIST								
Office/Support–Administrative	163	32,235	174	29,650	181	30,758	18	-1,477
Office/Support–Research	536	92,657	620	105,400	630	107,100	94	14,443
Laboratories/Support	included above	188,358	–	196,688	–	196,688		8,330
Facility Support/Storage	18	29,988	18	33,000	18	33,000	0	3,012
Subtotal	717	343,238	812	364,738	829	367,546	112	24,308
NTIA								
Offices/Support	70	16,112	85	14,450	110	18,700	40	2,588
Laboratories/Support	included above	12,340	–	12,340	–	12,340		0
Subtotal	70	28,452	85	26,790	110	31,040	40	2,588
NOAA in NIST Buildings								
Offices/Support	15 incl. in Shared		15 incl. in Shared		15 incl. in Shared			0
Laboratories/Support	–	389		389		389		0
Subtotal	0	389	0	389	0	389	0	0
NOAA in NOAA Buildings								
Office/Support (includes 9 GSA)	933	153,747	933	158,610	993	168,810	60	15,063
Laboratories/Support	included above	39,234	–	39,234	–	44,300		5,066
Other Support	–	35,135	–	35,135	–	36,000		865
Subtotal	933	228,116	933	232,979	993	249,110	60	20,994
Office of Security								
	0	0	–	600	–	600		600
Subtotal		0		600		600		600
SHARED FACILITIES								
Daycare	26	6,268	26	9,600	26	9,600	0	3,332
Library NIST Facilites	4	5,357	4	5,357	4	5,357	0	0
NOAA Facilites	–	1,752	–	1,752	–	1,752	0	0
Visitor Center	–	1,038	–	1,600	–	1,600		562
Cafeteria NIST Facilites	–	3,482	–	6,000	–	6,000		2,518
NOAA Facilites	–	4,717	–		–			-4,717
Conference Center NIST	–	11,817	–	14,000	–	14,000		2,183
NOAA Facilites	–	2,789	–	2,789	–	2,789		0
Fitness Center NIST	–	2,306	–	5,000	–	5,000		2,694
NOAA Facilites	–	1,378	–		–			-1,378
Computer Training	–	included above	–	–	–	-		0
Health Center	–	1,837	–	2,000	–	2,000		163
Mail Rooms	–	included above	–	–	–	-		0
Shipping Receiving (NOAA pers)	11	15,654	11	15,654	11	15,654	0	0
Warehouse/Storage	–	7,179	–	7,179	–	7,179		0
Collaboration–Allowance	–	0	–	1,000	–	1,000		1,000
Entry pavilion/Display/Badging	–	0	–	10,000	–	10,000		10,000
Subtotal	41	65,574	41	81,931	41	81,931	0	16,357
Campus Totals	**1,761**	**665,769**	**1,871**	**707,427**	**1,973**	**730,616**	**212**	**64,847**
Gross Square Feet		**1,254,174**						

This space program indicates the assignable square footage only, and the Master Plan includes additional gross square feet for appropriate support/infrastructure needed in lab renovation/replacement.

Support Space. Facility support space is maintained at the current square footage, with a modest increase to parallel lab and office growth. Some economies are expected by space efficiencies captured when the administration offices, support workshops and service areas are consolidated. Specific Master Plan assumptions include:

- Campus support space for facilities, maintenance and storage functions are scattered among several buildings, and inefficient in layout and use. Existing space is retained, although a modest reduction is expected when the master plan approach is finalized and these functions are consolidated into a more efficient building.
- For the Master Plan goal of creating opportunities for collaboration and additional employee amenities, an allowance of space has been added to the space program.

Shared Facilities. Certain services and employee amenities are shared campus-wide, including shipping/receiving, visitor center, library, health center, cafeteria and conference center space. The program allocates space based on specific functional need. The Childcare Center is maintained at the current enrollment, but space is added to bring the undersized facility to meet GSA guidelines. The Master Plan consolidates employee amenities in a campus center, and the space allocated to food service, fitness, meeting and collaboration areas reflect that goal.

3.3 Facility Needs

Facility needs, more than space needs, shaped the Master Plan approach. Many of the campus buildings are obsolete, whether for physical and functional condition, for lack of adequate research infrastructure or for inefficiency of size and location. As a result, the Master Plan replaces these obsolete facilities and removes them from the campus inventory. Consequently, more new square footage is proposed than indicated by the Program Space Needs shown in Exhibit 15. The facility replacements require additional square footage for the infrastructure to meet modern research needs and building codes. See Exhibit 6 in the Executive Summary for a summary of the difference.

Buildings/Space Added	+ 301,497 GSF
Buildings Removed	- 136,045 GSF
Difference	+ 165,452 GSF

Details are included in the Master Plan section. Specifically, the facility program includes:

- Research Buildings—replacement of Buildings 2 and 2A, replacement of the labs in Building 24, and renovation within Building 1 and 3.
- Administration and Support—consolidation of management resource administration and support functions in a new Management Resources Center, and the demolition/removal of the ten scattered buildings they currently occupy.
- Childcare Center—replacement of aging facility at current GSA standards

Exhibit 16: Program Needs—Facility Distribution

Organization	Additional Need: ASF	Where Accommodated
NIST		
Office/Support–Administration	-1,477*	Management Resources Center—replacement building
Office/Support–Research	14,433	Research Buildings—replacement buildings
Laboratories/Support	8,330	Research Buildings—replacement buildings
Facility Support	3,012	Distributed
NTIA		
Offices/Support	2,588	Building 1—renovation
NOAA		
Office/Support	15,063	NOAA Research Building—new
Laboratories/Support	5,066	NOAA Research Building—new
Other Support	865	NOAA Research Building—new
Office of Security		
	600	
Shared Facilities		
Childcare	3,332	Childcare Center—replacement building
Visitors Center	562	Visitor Center—expansion
Cafeteria	-2,199	Campus Center—consolidated facilities
Conference Center	2,183	Building 1—renovation
Fitness Center	1,316	Campus Center—consolidated facilities
Health Center	163	Campus Center—consolidated facilities
Collaboration allowance	1,000	Distributed
Entry Pavilion/Display	10,000	Visitor Entrance Pavilion—new
Total, assignable square feet	**64,847**	

* Office square footage developed under new space standards

3.4 Maximum Campus Space

The 1998 Amended Memorandum of Agreement with the City of Boulder set a maximum square footage for site build-out. This maximum square footage was modified to be 1,418,923 gross square feet by agreement between NIST and the City of Boulder[1] based on changed measurement methodology. The following adjustments correspond to the MOA modification.

Exhibit 17: Maximum Campus Space

	GSF	
Current campus space	1,254,174	
Building 33 re-measure*	+ 43,973	new methodology
Building 81 interstitial	- 77,465	mechanical equipment
Total	1,220,682	Existing GSF
Maximum allowed	1,418,923	Allowed by MOA
Remaining	198,241	permitted for Master Plan

* NOAA total 415,973 GSF under new measurement methodology.

1 Jane S. Brautigam, Boulder City Manager to Virginia Holtzman-Bell, Boulder Laboratories Site Manager; March 25, 2015; Boulder Colorado

4 Master Plan Concept

THE Master Plan development began with goals for the campus, and took shape based on the projected space needs and the detailed evaluation of the existing conditions of the site, infrastructure and buildings. Site concepts and layout alternatives were explored and evaluated by the design team in concert with a Steering Committee with representation from NIST, NTIA and NOAA. The chosen approach became the Master Plan. Staff and public comments received for design options under consideration helped solidify the direction of the selected concept.

4.1 Considerations for the Master Plan

The master plan looks to the future, anticipating growth and change to the Department of Commerce's mission and activities. But it also looks at today, and the campus issues that need improvement to achieve an efficient and pleasant workplace.

- Environmental Control. Much of the advanced research and measurement science taking place on the Boulder campus is based on precise performance and measurements, which demand very controlled environments—rigorous temperature and humidity control, vibration stability, air cleanliness and quality electric power. Other than in Buildings 81 and 33, these conditions are difficult to achieve. Researchers make due in the older lab buildings, but time is often wasted and experiments sidelined. Renovations to several Wings of Building 1 are expected to greatly improve the conditions there.
- Complexity of Public Forums. Holding a conference or public forum on campus requires visitor badging, vehicle screening, parking arrangements and coffee or food catering from an outside vendor. NIST would like to expand interaction with outside groups by easing this complexity, and creating a separate parking and conference zone with fewer security requirements.
- Lack of a Campus Organizing Principle. The campus layout reflects its incremental growth stemming from space need, and does not have a unifying vision or organization. There is no recognizable core that gives the campus identity as a place, like the rhythm of GPLs does at Gaithersburg, or a quad does for a university. Circulation from building-to-building is not straightforward; front doors are not used; wayfinding is difficult. The vehicle entrance has shifted from its original location, which had a direct view of the front of Building 1, to a location that shows guests a side view of the buildings.
- Limited Collaboration Opportunities. The campus, particularly the NIST precinct, has no areas that draw people together informally, either in a central location or within buildings. The NIST cafeteria is no longer open, and many break rooms and small meeting areas have become offices and lab support areas as space pressure increases.
- Inefficiency of Small, Modular and Aging Buildings. Incremental growth on campus has been addressed by adding modular buildings, small buildings and additions—resulting in functional and physical inefficiencies and an unorganized campus. In all, there are 10 modular buildings on campus, together with another 10 small buildings, each less than 4,000 square feet. Each of these has its own services and mechanical system.
- Scattered Management Resource Functions. Administrative functions—construction, facility management, maintenance, IT services and support—are all located in separate small buildings, seven in all. Lost are easy

opportunities for coordination and sharing of resources, equipment and support.

- Circulation and Screening Conflicts. Congestion is apparent at the campus entrance and Security Center, where all visitors must get badges and non-employee vehicles must be screened. Maneuvering room is limited, and it is not possible to inspect a large delivery truck and passenger vehicles at the same time. The vehicle screening process is not apparent to visitors and they often need to circle back around and reenter the screening area. Visitors arriving by public transportation or on foot do not have signage directing them to the Security Center.
- Development Restrictions of the MOA and Community Requirements. Any future development must consider the Memorandum of Agreement (MOA), which sets limits on campus total square footage, parking, building heights and view to Kohler Mesa. In addition to the MOA, other regulatory considerations include: State Historic Preservation Officer review; EPA Stormwater Permit modifications; Federal energy and sustainable design considerations.
- Community Concerns. Public use on the campus is a community consideration, and the Master Plan makes no changes to the trails in the protected area. The DoC strives to be a good neighbor, working with the neighbors to identify and mitigate any complaints about noise or the shielding of site lighting.
- Historic Preservation. The Radio Building (Building 1) is eligible for listing on the National Register of Historic Places, according to the Colorado Office of Archaeology and Historic Preservation, which functions as the State Historic Preservation Officer (SHPO) in Colorado. Future modifications to this building require review under Section 106 of the National Historic Preservation Act. SHPO has suggested that renovations be approached as Rehabilitation, which is one of four treatment methods, defined as the act or process of making possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features which convey its historical, cultural, or architectural values.
- Projects in Motion. As the master plan is being developed, several NIST projects are underway.

  Communications Technology Laboratory: Repurposing & expansion of Building 3

  Temporary moves from B1 Wing 5 to prepare for renovation, including the NIST Central Computing Center to a temporary modular building and Police facilities to B22.

4.2 Master Plan Concept

The Master Plan concept creates appropriate facilities to support the work of the DoC agencies, but it also strives to create a vibrant campus with an organized layout, employee amenities and an appreciation of the natural surroundings. The campus environment is intended to enhance the working environment, encourage employee interaction, and provide a sense of place and pride in the institution.

Research facilities are the building blocks of the Master Plan, directly serving over three-quarters of the staff from NIST, NTIA and NOAA. The Radio Building, one of the original research buildings, is linked to the most recent NIST laboratory, the Katharine Blodgett Gebbie Laboratory Building 81. This interactive approach allows easy movement between buildings for both staff and equipment. The Master Plan continues this strategy for NIST, linking new research buildings in a linear concept. These connections are central to the concept and one of the reasons for the selection of this approach. Ease of movement is important, especially in inclement weather, as is the flexibility for sharing resources and accommodating shifts in lab assignments.

The campus green enhances the relationship between the research buildings, and ties together the research facilities that cannot be directly connected. The green provides organization and visual cohesion as well as an outdoor amenity. A new campus center is an element within the campus green, positioned to welcome staff from both NIST and NOAA buildings with food service, shared services and informal collaboration spaces.

A new plaza created at the head house of the Radio Building becomes DoC's public face in Boulder. The plaza links a public/staff parking area with conference facilities in the Radio Building and provides a venue for outdoor events on campus. The front of the Radio Building was the original campus entrance, and its conference center remains the location for the most on-campus conferences. In recent years, security policies caused the campus entrance to move, and required vehicle screening before entering the campus. This has made conferences with outside colleagues more difficult to manage and schedule. The Master Plan reestablishes a zone in which

Exhibit 18: Master Plan

visitors can park without vehicle screening and walk to the conference center for personal screening at the entrance. The goal is to encourage greater public forums and bring back conferences that are now held off-campus for convenience.

Support and service facilities are concentrated up the hill to the west of the research buildings. The Central Utility Plant, the planned Management Resources building and the Warehouse surround an open yard with parking for service vehicles. Vehicle access is from Curie Circle, the campus ring road. Pedestrians also can gain access to the Central Utility Plant and the Management Resources building from the campus green's walkway.

Open Space encompasses approximately one-half of the campus land, and incorporates the areas protected under agreement with the Tribes and the City of Boulder. The 103.5 acre protected area begins in front of NOAA at Broadway Street, extends across the southern portion of the property and the western third. Within this open space is an existing secondary research area at the top of Kohler Mesa, established for specific programs. The Master Plan does not propose any buildings or roadways in the open space.

4.3 Master Plan Elements

Research is the heart and the business of the Boulder campus. Mission, research methods and technology have evolved since the construction of the buildings slated to be renovated and replaced, and this advanced research requires more sophisticated buildings. New facilities will strive for flexible, adaptable lab facilities, precise environmental control and efficient, comfortable working conditions for the researchers.

The Master Plan puts these objectives at its center, with the following research components.

Building 1 Renovation

The Radio Building 1 is the core research building from the initial 1954 campus construction, and remains an iconic, recognizable building on the campus. A one-story conference center and library make up the front of the building, facing Broadway. From that head-house, a three story spine links six wings of laboratory and offices space. The building has been undergoing a phased renovation and upgrade program, to replace outdated systems and meet the performance level required by NIST's research.

Renovation of Wings 3 and 6 has just been completed with occupancy in 2017. These two wings have undergone complete replacement of infrastructure, systems and architectural elements. An accessible service corridor was added along the northern perimeter of each wing to house mechanical equipment for individual labs as well as the wing as a whole. The accessible service corridor also was added to provide seismic reinforcement required by current building code. The façade was replaced with an insulated panel and glazing system. Planned renovation of Wings 5, 4 and Spine is anticipated to follow a similar approach, while respecting the building's historic features. The renovation of Wings 1 and 2 will follow, although the timeframe has not been established. Building 1 was recently determined to be eligible for listing on the National Register of Historic Places. All renovations in Building 1 will be governed by the National Historic Preservation Act and the Secretary of the Interior's Standards for Rehabilitation. Plans will be submitted to Colorado SHPO for review and comment.

Building 3 Renovation and Expansion

The Liquefier Building 3 will be repurposed and expanded to serve as the headquarters of the Communications Technology Laboratory (CTL). This project is under construction and is expected to be completed in late 2017. The existing building is a single story, high bay concrete structure initially constructed in 1952. The repurposing will significantly change the appearance and the space within, creating three-stories of offices and computer laboratories. The building envelope will be replaced, although key elements from the original building will be retained.

A later addition to Building 3 is included in the Master Plan. The antenna laboratories now located in Building 24 are associated with CTL programs and will be replaced in the Building 3 addition.

Exhibit 19: Concept—NIST Ground Floor Plans

New NIST Replacement Research Buildings

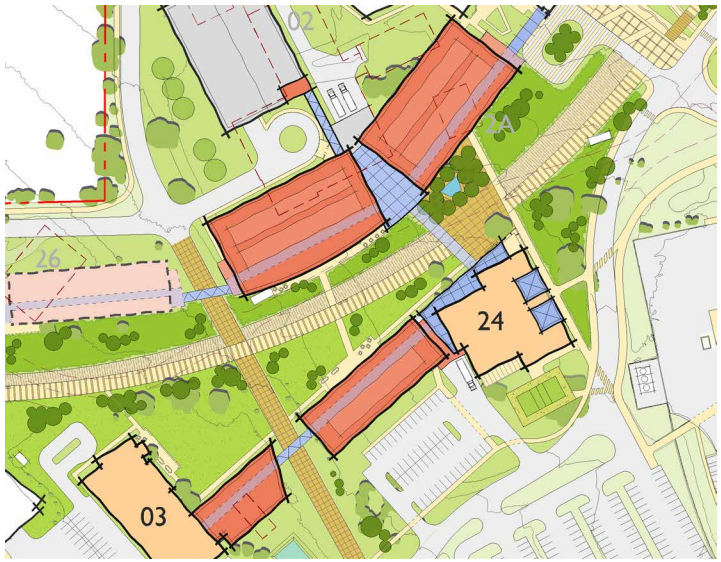
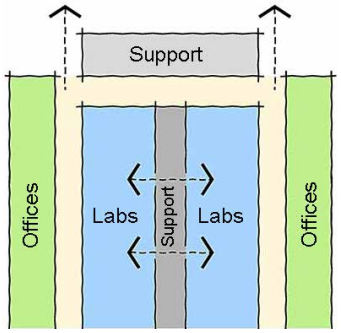


Exhibit 20: Replacement Research Buildings

New research buildings are the heart of the Master Plan concept, linking new facilities to old, and defining the central green space. The new laboratories will provide the flexibility, infrastructure and controlled environments needed to support advanced research. Two NIST laboratory buildings, Buildings 2 and 2A, will be replaced. The labs in Building 24 will be replaced and the building repurposed. Both Buildings 2 and 24 are aging facilities (1951 and 1967), each with several additions, functional problems and systems well past their useful lives. Building 2A is a 27-year old "temporary" modular building.

Exhibit 22: Laboratory Plan



The new research buildings are indicated as general purpose labs in the Master Plan. General Purpose Laboratory is a NIST designation for flexible facilities of labs and related offices and support that can be adapted to many research projects. The typical configuration has three component zones: office, lab and service. There is an office section along one window wall, with laboratories and support across a common corridor. The third component is a service galley along the length of the labs, providing space for service and lab equipment. The labs consist of modules of consistent size that can be combined for specific projects. This three-part configuration has been used in the renovation of Building 1 wings. A double configuration is more efficient for both space and systems, in which there are offices along both long window walls, two sections of labs in the middle sharing one service galley.

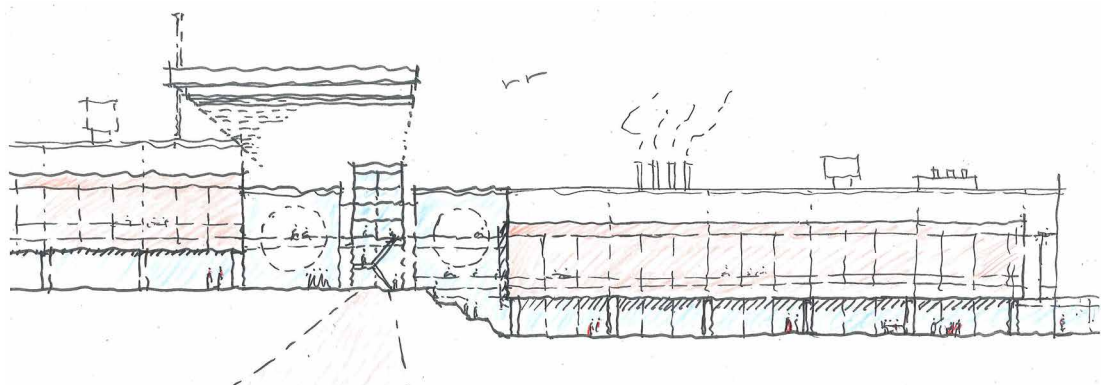
The Master Plan utilizes this configuration for the replacement laboratory buildings, recognizing that special configurations may be substituted as missions evolve. Building 2 contains high-bay laboratory space that would be accommodated in any replacement scenario. Two new research buildings are assumed to accommodate the research programs now housed in Buildings 2, 2A and part of 24. One building would be located west of Building 81, framing one side of the campus green.

Exhibit 21: Concept—Laboratory Section

Its proposed location directly adjacent and slightly overlapping the footprint of existing Building 2 provides a direct connection to Building 81 and avoids the existing utility tunnel. NIST is prepared to provide swing space so that Building 2 can be partially demolished for its replacement. The second research building frames the south side of the campus green, located adjacent to Building 24 on the current parking lot.

The Katharine Blodgett Gebbie Laboratory, Building 81, is not changing in the Master Plan, but is the anchoring point for the replacement labs as well as the campus green. Movement and connection for both people and equipment is a functional requirement. Building 81 is the knuckle, linking the new laboratories with those in the Radio Building.

Exhibit 23: Concept—Building 2 Replacement Laboratory



Building 2—Existing

Building 34 Renovation and Expansion

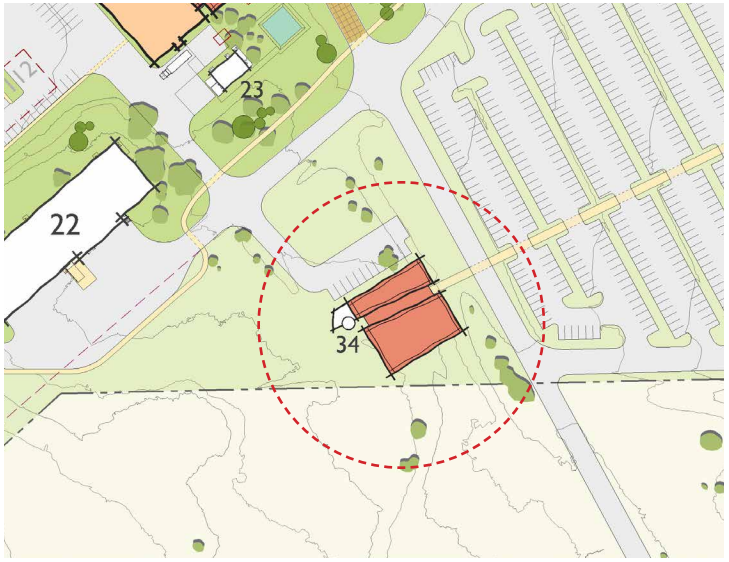


Exhibit 24: Building 34 Expansion

NOAA's Observatory Building 34 is isolated from the main building, and is underutilized at this time. The National Weather Service needs additional research space, and the Master Plan proposes that Building 34 be preserved, repurposed and expanded to serve this group. Initial discussions are underway, and the Plan indicates the general approach and preliminary size.

Management Resources Center

Exhibit 25: Management Resources Center

Consolidation of NIST's management and facility support groups is designed to increase efficiency, both functional and physical. Located in 10 small buildings plus the Radio Building, these groups can't take advantage of adjacency to coordinate and collaborate. Both efforts and resources are duplicated, e.g. copy rooms, conference rooms, break rooms, rest rooms, filing and reception. Many of the ten existing small buildings are not in good physical condition; eight of the ten are temporary buildings and/or trailers. For example, Buildings 4 and 5 were constructed as temporary buildings in 1951 at the initial campus development, and have remained in use for these last 55 years. In addition to human efficiency, energy efficiency can be gained in consolidation, as the multiple individual package HVAC units are replaced with a central system.

The Master Plan approach creates a new Management Resources Center located along Curie Circle at the western end of the campus green, near the Central Utility Plant and the utility yard. Approximately 50% of the Center would be office areas, with office support space shared among the groups. The remainder would be maintenance shops, personnel support, supplies and storage, replacing the functions of the demolished buildings.

Although located together for functional reasons, the design requirements for each component are very different—different mechanical systems, different daylighting, different finishes—for the most energy efficient and appropriate concept. The preliminary concept suggests that maintenance shops and storage could be primarily day-lit, utilizing north-facing monitors that could have solar panels on their south sides. The shops might use natural ventilation, augmented when necessary, and the storage areas could use underfloor heating to efficiently keep the lower area comfortable for people. The office portion would have more typical comfort requirements and systems. Daylighting could provide much of the illumination for the office section too, by careful consideration of the building depth, orientation, internal layout and façade design. Although the Management Resources Center could be a single building, the Master Plan shows it as two connected facilities to allow vehicular access to the CUP without interrupting the campus green. Net-zero energy use is the goal for this facility.

Preliminary occupants for the Center would be primarily from the Office of Facilities and Property Management, including both office and shop functions, plus other management groups. Proposed occupants are the following:

- OFPM administrative–office space — now in B1, B3A, B4, B5, B21, B91 and B131
- OFPM maintenance and support–offices and shops — now in B21, B25, B25MI, B91 and B112
- Acquisition Management –office space — now in B111
- Central Computing Center — now B1, moving to temporary location in 2016
- Storage — now in B4, B25 and shipping containers

Some of the NIST administrative staff would not move to the new Management Resources Center, but remain adjacent to their service areas. Specifically, the Safety, Health and Environment staff would remain located near the research laboratories, and the OFPM building management teams would remain within their assigned buildings. Administrative staff members that directly serve the Laboratories would remain in the research buildings. Public Affairs office staff would be moved from laboratory office space to the Conference Center environs. Customer service desks for computer or facility issues and library assistance would be well located in the Campus Center.

The consolidation will reduce the overall assignable square footage needed by these groups, as well as increasing physical and functional efficiency. Approximately 100 staff are planned to have office space and shared support in the Center, consolidating them from the buildings to be demolished as well as freeing up space in Building 1. Maintenance shop areas can share support, and consolidated storage space can incorporate efficient warehouse shelving systems. Storage functions currently using 43 shipping containers should be included.

Exhibit 26: Concept—Management Resources Center

Campus Center

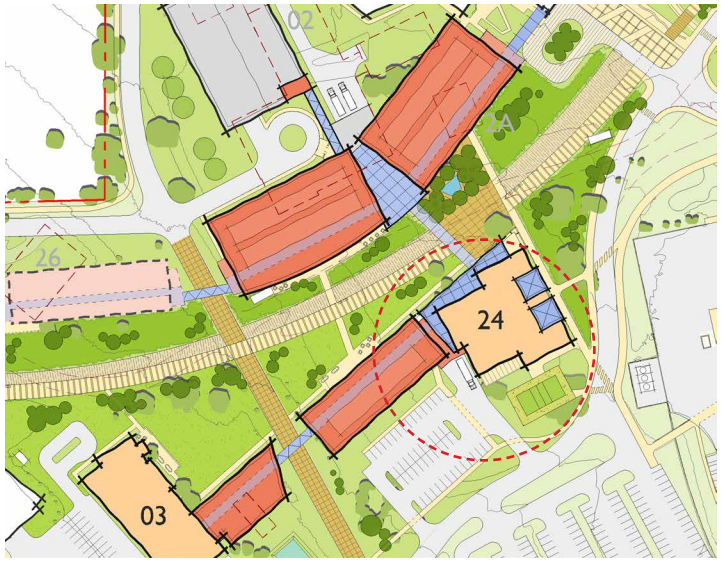


Exhibit 27: Campus Center

One of the fundamental Master Plan concepts is the creation of a welcoming Campus Center near the research buildings, which would concentrate most employee amenities and services in one area. The Campus Center is planned as a renovation of Building 24, established after moving the research functions from there to more appropriate facilities. Building 24 is located between NOAA and NIST, with pedestrian connections and outdoor spaces intended to draw employees from each. The concept would strengthen the pedestrian realm of the campus, and foster a greater sense of community among all DoC staff. The planned facilities and common spaces will create lively gathering places and central services to draw in employees. The program for the Campus Center consolidates shared services from other campus buildings, and includes a cafeteria, fitness center, health center, retail store, meeting rooms, informal collaboration/lounge areas and service desks for Library, IT and Facilities.

The center would retain the structure of Building 24, taking advantage of the high bay area for dining and fitness activities. The Plan proposes that the building setbacks on the east be enclosed to create a high ceilinged lounge space that would be visible from the entrance road and the campus green. Dual entrances on the north and south would welcome employees from both NIST and NOAA, and outdoor areas would provide recreation and connection to the campus green and research buildings. LEED Gold certification is the goal for this facility.

Components of the planned Campus Center are located today in Buildings 33 and Building 1. Consolidating them into the new center will free up space in these research buildings for research functions. Moving the retail function of the storeroom from Building 22 Warehouse will make this store more convenient and will free-up space for storage to replace the many shipping containers or other displaced storage.

Exhibit 28: Concept:Campus Center Cafeteria

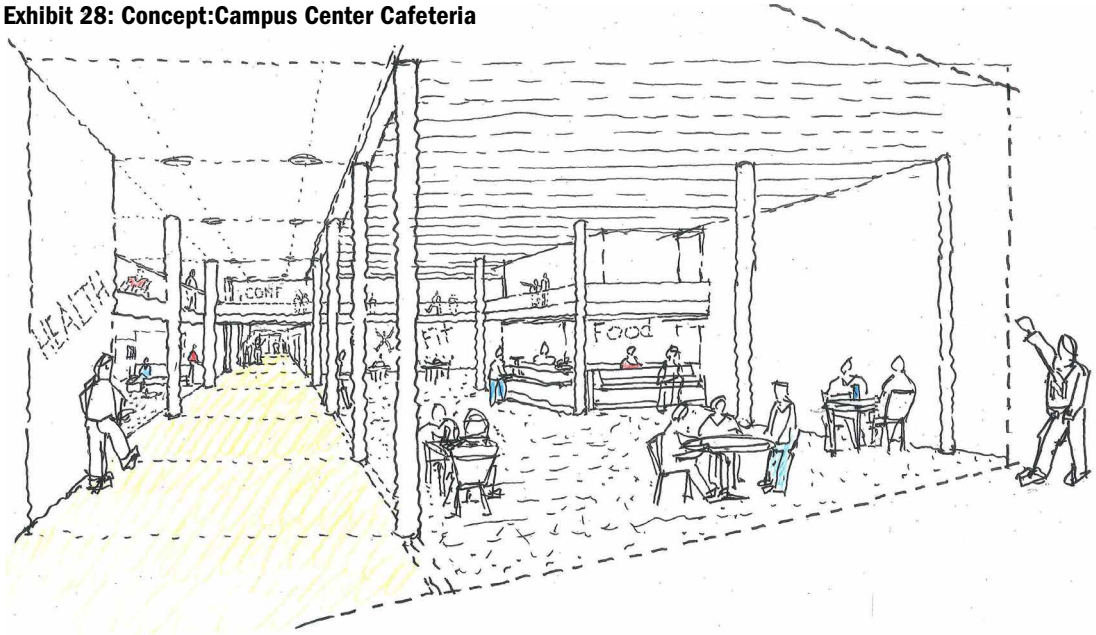


Exhibit 29: B24 Campus Center—Space Gained in Other Buildings

	Space Gained*	Components Moved to Campus Center
Building 33—NOAA	8,000 asf	Cafeteria, Fitness, Health Center
Building 1—NIST	6,700 asf	Cafeteria, Fitness, Help desks
Building 22—NIST	2,000 asf	Retail store

*If all spaces move. NOAA or NIST may elect to retain satellite facilities.

Conference Center and Visitor Pavilion

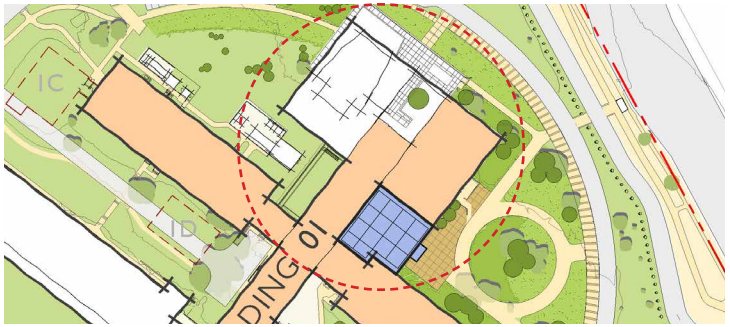


Exhibit 30: Visitor Pavilion

The main conference facility, shared by NIST, NOAA and NTIA, is located at the "front" of the Radio Building facing Broadway. The recently renovated auditorium opens to the original 1954 lobby space, as do several meeting rooms and the Library. In the past, these facilities and an adjacent cafeteria (now closed) were open to the public, but now security policy requires that a visitor entering a campus building be sponsored by a DoC employee, obtain a visitor badge and have their car screened before entering campus. This complexity has discouraged on-campus conferences and public forums, reducing their number. The Master Plan addresses the goal of easing interaction with the following:

- Adding a visitor parking lot
- Creating a new visitor entrance/security pavilion
- Enhancing the Conference Center facilities

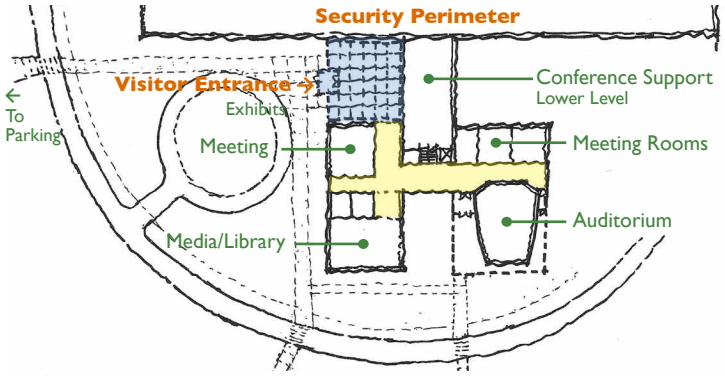
A parking lot near the campus entrance is proposed, which would be accessible to both staff and visitors without vehicle screening. The lot would be separate from the campus circulation system, with entrance and exit from Broadway. Visitors parking here could walk onto the campus, and receive security screening for a conference at the Radio Building. (The Boulder campus is not fenced, and pedestrians are permitted free access to the campus grounds, but must be badged to enter buildings.) NIST is discussing various control procedures to make parking convenient but preserve the lot for DoC staff and their visitors.

The Master Plan envisions the Conference Center area as a public zone, where screening by magnetometer would replace sponsorship and formal badging. Visitors thus screened would be restricted to the Conference Center spaces. To facilitate this, a new entrance pavilion is proposed, between B1-Wing 2 and the Conference Center. The pavilion would house the security screening area and welcome desk, preserving the original lobby space of Building 1. A museum of Boulder campus history displays and research artifacts is proposed, pulling these items from various storage spaces. The pavilion is envisioned as a light filled open space, visible from the visitor parking. Walkway, landscaping and signage should create a welcoming image and signal that this is the visitor entrance. One of the B1 loading docks would need to be relocated.

The Conference Center itself will recapture space for additional meeting rooms and Public Affairs offices with the release of swing space being used while laboratory space in other Building 1 wings are under renovation. The Master Plan retains the Library space for its architectural integrity as well as its function. Library use has evolved over the last few years, and research assistance and on-line resources have become more requested than books. The nature of the library space also will evolve, possibly with high-tech collaboration spaces.

Exhibit 31: Concept—Visitor Pavilion and Plaza

Exhibit 32: Concept—Conference Center



Security Center Modification

Exhibit 33: Security Center

Located at the campus entrance, the Center provides front-line security, screening visitors and vehicles before they enter the campus. The number of visitors and the screening process have changed since the facility was built. The current building is not adequate for the processing functions, the flow of visitors through the metal detectors and the added facilities for a supervisor and fingerprinting. Expansion or complete replacement is proposed to ease the congestion and improve the efficiency.

Screening of vehicles would also be modified to improve security and ease congestion. The screening area for truck and private cars would be separated, and the turning, or reject, drive would be reconfigured. These changes are best accomplished in coordination with the Conference Center and Visitor entrance parking.

Childcare Center Replacement

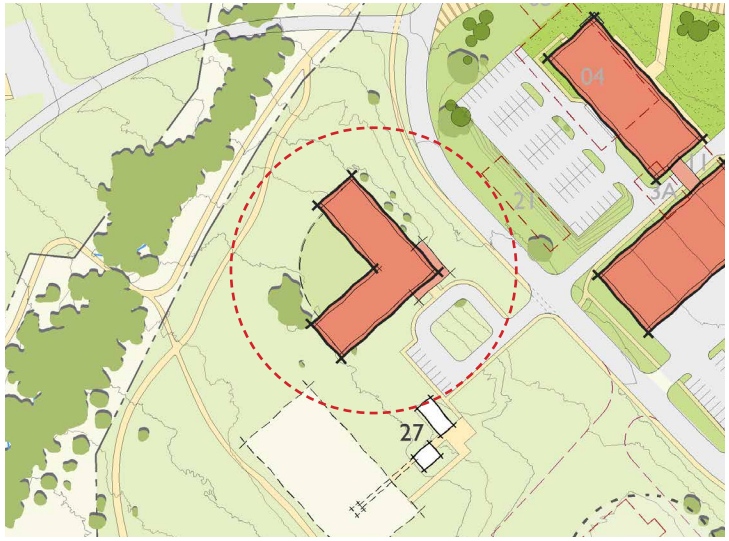


Exhibit 34: Childcare Center

The existing Childcare Center, Building 26, occupies two modular buildings, the first completed in 1989 and the second added and integrated in 1995. Space is very tight, and the building is in fair-to-poor physical condition, with many of the original mechanical systems. The building is owned and maintained by NIST but operated by the Commerce Children's Center, an independent contractor. Children range in age from infants to pre-K. Enrollment in late 2015 was 104, with approximately 90 children attending on a typical day.

The Master Plan replaces this aging and functionally inadequate building, and moves childcare from the center of campus to allow for the future expansion of research buildings in a contiguous and connected way. It locates the building at the western part where it has its own vehicular drive and drop-off. The planned capacity for the Childcare Center remains the same, although the square footage is approximately 50% larger, meeting the guidelines of the *Child Care Design Guide*, GSA Public Building Service, July 2003. This was also the standard used in the development of the Childcare Center at NIST Gaithersburg.

As a new building, net-zero energy use is the goal, with the potential incorporation of ample daylighting, energy efficient envelope, solar photovoltaics, and other sustainable design strategies.

Exhibit 35: Concept—View of Central Campus

Buildings Removed

Replacement of outdated and inadequate facilities will allow the removal of 15 buildings on the campus. The majority of these are small—9 buildings are less than 4,000 GSF and another 4 are less than 10,000 GSF. Most of these small buildings would be removed when the Management Resources Center is constructed and occupied, including 8 buildings that were introduced as temporary buildings. The largest building to be demolished is the laboratory Building 2. See the Buildings Removed exhibit for a list. Replacement and removal of these buildings is central to the Master Plan, fulfilling these objectives:

- Functional Efficiency. Consolidation of administrative and support staff in one location rather than multiple buildings will improve coordination, supervision and collaboration, for more efficient operations. In parallel, duplication of support spaces will be minimized. For the Laboratories, new buildings will provide more consistent and appropriate lab modules and eliminate layout irregularities that are the result of multiple additions to Buildings 2 and 24.
- Environmental Control. Existing laboratories are not capable of providing the controlled environments necessary for advanced research—temperature and humidity, vibration stability, air cleanliness and quality electrical power.
- Energy and System Efficiency. New and consolidated facilities will have modern mechanical, electrical and plumbing systems, replacing the multiple obsolete systems.
- Campus Organization. Removal of these scattered buildings supports the Master Plan's organizing principle of a central green created by linked research buildings, and it removes the visual clutter of the existing campus.
- Meeting agreements with the City of Boulder. NIST has an agreement with the City that limits the square footage on the campus. To add the new Master Plan facilities, buildings must be removed to remain below the maximum.
- Conex Removal. Creation of efficient storage space with a structured shelving system would allow the consolidation of storage in various locations, including that stored in multiple shipping container (Conexes) scattered across the campus.

Exhibit 36: Campus Buildings Removed

Buildings Removed		Built	GSF	Notes
Building 2	Laboratory	1951	69,771	Replace
Building 2A	Laboratory	1989	2,880	Replace
Building 1C	Lab Offices	1989	4,611	Consolidate w/ B1 renovation
Building 1D	Lab Offices	1992	3,456	Consolidate w/ B1 renovation
Building 3A	Offices	1989	2,160	Consolidate—new Management Resource Center
Buildings 4	Offices	1951	15,795	Consolidate—new Management Resource Center
Building 5	Offices, 1 Lab	1951	3,149	Consolidate—new Management Resource Center
Building 21	Garage	1963	3,999	Consolidate—new Management Resource Center
Building 25	Maintenance Shops	1966	8,306	Consolidate—new Management Resource Center
Building 25MI	Offices	—	525	Consolidate—new Management Resource Center
Building 26	Childcare	1989	7,776	Replace
Building 91	Offices	2008	3,561	Consolidate—new Management Resource Center
Building 111	Offices	2011	2,821	Consolidate—new Management Resource Center
Building 112	Maintenance/Storage	2011	5,795	Consolidate—new Management Resource Center
Building 131	Offices	2013	1,440	Consolidate—new Management Resource Center
Removed Total			**136,045**	**GSF**

Exhibit 37: Campus Buildings and Space Added

Components Added	GSF	Notes
Building 3 Expansion	25,597	Communications Technology Laboratory
B1, Wing 5, 4, Spine Renovation/addition	14,000	Estimated additions
Management Resources Center	60,000	Consolidates 10 Buildings
Laboratory Replacement	125,000	Replaces B2, B2A, part B24
Visitor Pavilion–Building 1	10,000	Visitor Entry, Security. Display
Lab Addition–Building 3	17,500	Antenna labs from B24
Campus Center–B24 Renovation	3,000	Staff Amenities and Services
Childcare Center Replacement	13,000	Replaces outdated, crowded facility
Security Center Addition–B51	800	Ease overcrowding in Security Center
NOAA Laboratory–B34 addition	32,600	National Weather Service labs
Added Total	**301,497**	**GSF**

Exhibit 38: Campus Buildings Retained

Buildings Retained		Built	GSF	Notes
Building 1	Laboratory/office	1954	336,909	Radio Building; renovation; NRHP eligible
Building 3	Laboratory/support	1952	17,403	Repurposed/expanded for CTL labs
Building 8	Laboratory	1953	2,400	Cryogenic Mesa Site
Building 11	Laboratory	1958	466	Ionospheric Observatory
Buildings 12	Laboratory	2010	1,446	Hydrogen Test Facility
Building 22	Warehouse	1964	17,530	Shipping/receiving; Storage
Building 23	Suppor	1989	984	Hazardous Materials
Building 24	(Laboratory)	1967	32,723	Becomes Campus Center w/ addition
Building 27	Laboratory	1992	1,045	High Frequency Field Site
Building 33	Laboratory/office	1999	372,000*	NOAA's main facility
Building 34	Laboratory	–	incl. above	Becomes NOAA lab w/ addition
Building 42	Utility	2005	45,845	Central Utility Plant
Building 51	Security	2006	1,470	Visitor Center–screening
Building 81	Laboratory	2012	286,674	Katharine Blodgett Gebbie Laboratory
Concourse		2012	1,234	Connects Buildings 1 and 81
Retained Buildings Total			**1,118,129**	**GSF, Occupied Buildings**
Structures Retained		**Built**	**GSF**	**Notes**
Building 1E	Annex	–	1,664	Mechanical Equipment
Building 1F	Annex	–	2,766	Mechanical Equipment
Building 9	Gas Meter Bldg.	1958	378	Water Pump Equipment
Building 23A	B23 Annex	1989	211	Mechanical Equipment
Building 41	Hi-Speed Switch	–	1,669	Electrical Equipment
Retained Structures Total			**6,688**	**GSF**

*NOAA now reports 415.973 GSF as existing, because of changed measurement methodology: see Program section.

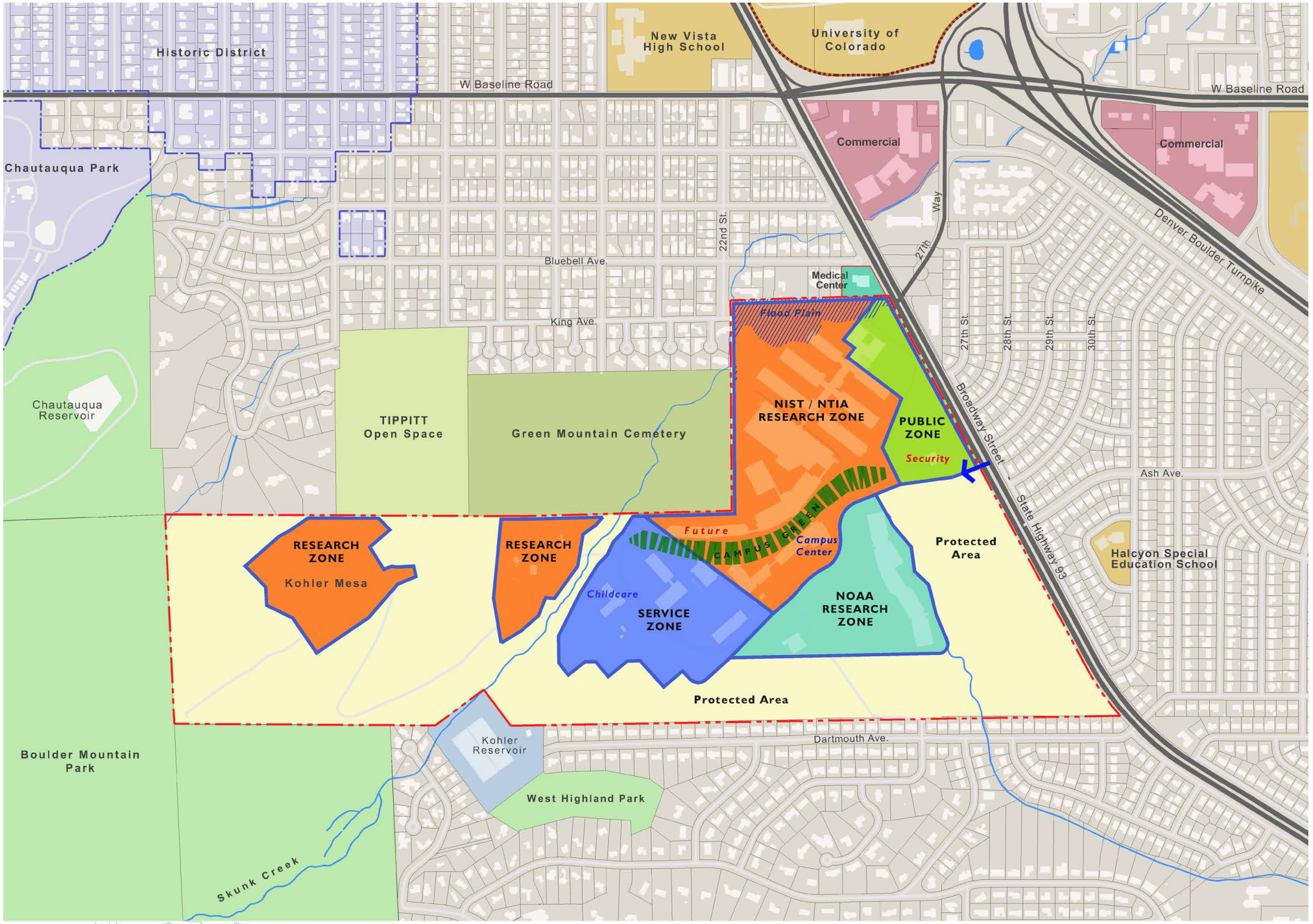
Exhibit 39: Building Changes

	Building Number and Name[1]	Existing GSF	Add	Subtract	Proposed GSF	Notes
1	Radio Building	336,909	14,000		350,909	Add service galleys–Wings 4, 5
1C	Annex	4,611		4,611	0	
1D	Annex	3,456		3,456	0	
2	Cryogenic	69,771		69,771	0	
2A	Cryogenic Annex	2,880		2,880	0	
3	Liquifier	17,403	25,597	0	43,000	CTL program
3A	EMSS Annex	2,160		2,160	0	
4	Camco	15,795		15,795	0	
5	Camco Annex	3,149		3,149	0	
8	Cryogenic Mesa Test	2,400			2,400	
11	Ionospheric Observatory	466			466	
12	Hydrogen Test Facility	1,446			1,446	
21	Maintenance Garage	3,999		3,999	0	
22	Warehouse	17,530			17,530	
23	Hazardous Materials	984			984	
24	Plasma Physics	32,723	3,000		35,723	Fill courtyards + 1000 sf
25	Maintenance Shop	8,306		8,306	0	
25MI	Building 25 Annex	525		525	0	
26	Childcare Center	7,776	13,000	7,776	13,000	Replacement at GSA program
27	High Frequency Field Site	1,045			1,045	
42	Central Utility Plant	45,845			45,845	
51	Security Center	1,470	800		2,270	Expand for function
81	Gebbie Laboratory	286,674			286,674	
91	Construction Research	3,561		3,561	0	
111	Building 4 Annex	2,821		2,821	0	
112	Butler Building	5,795		5,795	0	
131	Office	1,440		1,440	0	
–	Concourse	1,234			1,234	
	New Management Resources Center	0	60,000		60,000	Admin. & Support consolidation
	Entry Pavilion	0	10,000		10,000	
	B3-CTL Expansion	0	17,500		17,500	7000 existing x 2.5
	New Labs	0	125,000		125,000	
	NIST Total	882,174	268,897	136,045	1,015,026	
33	Skaggs Research Center	372,000			372,000[2]	
34	NOAA Solar Observatory	included above	32,600		32,600	Expansion for NWS
	Site Total, overall GSF difference	**1,254,174**	**301,497**	**136,045**	**1,419,626**	

1 Table shows Occupied Buildings only. Other named buildings are structures containing mechanical, electrical or plumbing equipment only:
- 1E Annex (mechanical equipment)
- 1F Annex (mechanical equipment)
- 9 Gas Meter Building (water pump equipment)
- 23A Annex (mechanical equipment)
- 41 Hi-Speed Switch (electrical equipment)

2 NOAA now reports 415.973 GSF as existing, because of changed measurement methodology: see Program section.

Exhibit 40: Proposed Land Use



4.4 Master Plan Development

The Master Plan is the result of a comprehensive study of campus-wide physical and functional conditions and research program goals. Two phase reports preceded the Master Plan: a) Contextual Analysis, which studied the current site, buildings, infrastructure and interaction with the local community; and b) Alternatives, which explored different approaches to meeting the goals and issues uncovered.

Four campus plan concepts were developed, exploring different approaches to meeting the Master Plan goals and accommodating the future program. Each concept solved the same problems and accommodated the same functional elements, but in differing ways and different locations. The concepts were reviewed with a Department of Commerce steering committee composed of representatives of NOAA, NIST and NTIA. The approaches were evaluated against facility, functional and implementation factors, including the following: accommodation of research, support and staff activities; flexibility; energy and maintenance efficiency; campus character and image; and potential implementation costs. The concepts each included the same existing infrastructure and buildings. The concepts were:

A. Office and Service Consolidation Concept

Alternative A gradually addresses campus needs, while minimizing changes to the campus organization and circulation. NIST and NTIA research needs would be met by renovation of the existing buildings—continuing the renovation of Building 1 wings, followed by Buildings 24 and 2. NOAA augments their research capabilities with an expansion of Building 34 for National Weather Service facilities. One major element is the consolidation of most NIST management resource staff with the campus support functions into a single building, allowing the demolition of a number of outdated, modular and/or inefficient buildings. Consolidation would yield savings in space and utility costs, as well as improved productivity.

Exhibit 41: Alternative A

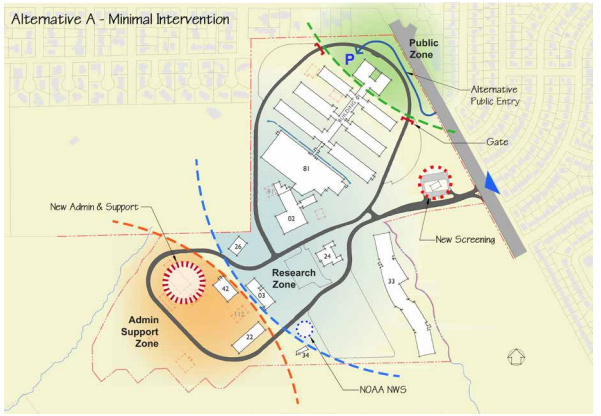


Exhibit 42: Alternative A Plan

B. Campus Center Concept

Alternative B establishes a new campus center building, creating a functional and physical organizing element. The new building consolidates NIST management resource staff and facility support that currently is scattered among several buildings. The campus center relates to both NIST and NOAA, and becomes a focal point for shared services and amenities, such as food service, fitness, health center, police dispatch, and media. A separate building consolidates the campus maintenance and support functions. Lab buildings 2 and 24 are subsequently replaced, creating a research quad adjacent to the campus center. Removal of shared amenities from NOAA Building 33 captures additional research space for the National Weather Service.

Exhibit 43: Alternative B

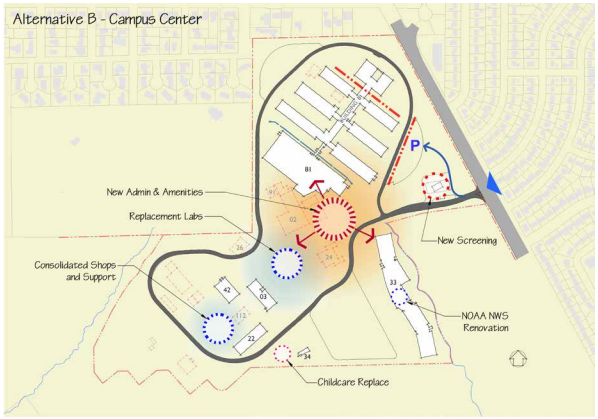


Exhibit 44: Alternative B Plan

C. Discrete Research Centers Concept

Alternative C proposes that new laboratories replacing Buildings 2 and 24 may benefit from their own precinct, a separate identity and an interrelated cluster. The campus road loop is expanded on the west to create a site for new buildings, providing flexibility in building shape as well as a more direct relationship with sites on the mesa. The center of campus is opened up for shared services and recreation. Like Alternative B, a central building consolidates NIST Management Resources offices and shared amenities. Childcare may be located in this central area, or alternatively in the tribal zone, if permitted. NOAA's National Weather Service facility is located on GSA-controlled land, in proximity to NOAA's Building 34.

Exhibit 45: Alternative C

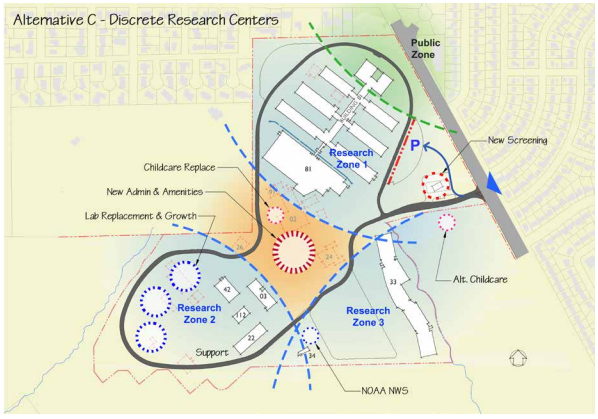


Exhibit 46: Alternative C Plan

D. Pedestrian Linkages Concept

Alternative D establishes a new campus front door by creating an entrance pavilion and emphasizing public and conference center space in the Building 1. This focal point anchors a pedestrian pathway that links the existing and new buildings, replacing the center roadway. NIST management resource staff offices are located adjacent to the entrance pavilion, and a separate building on the western part of the campus consolidates maintenance and support functions. Lab buildings 2 and 24 are subsequently replaced, and linked into the pedestrian system. An addition to Building 34 provides space for NOAA's National Weather Service facilities.

Exhibit 47: Alternative D

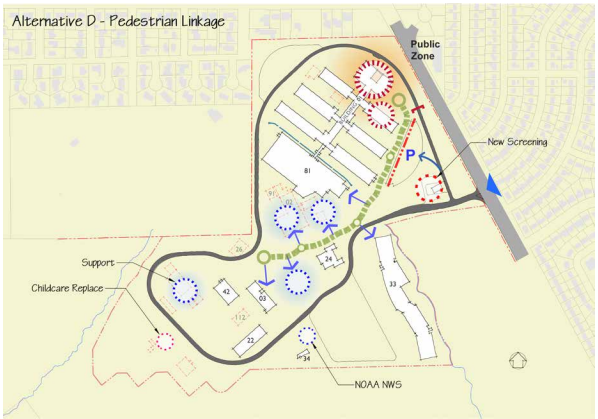


Exhibit 48: Alternative D Plan

Exhibit 49: Concept—Selected Approach

Selected Alternative

The Master Plan approach was selected by the Steering committee after evaluation of the four alternative approaches. The final approach emerged as a hybrid of key elements from the four initial alternatives—consolidation of management staff and services, a pedestrian spine both outdoors and within buildings, a campus center for staff amenities and services, and replacement for obsolete laboratory space. The Master Plan concept was developed further to coordinate architecture, infrastructure, landscaping, circulation and implementation strategy. In selecting the option, the Steering Committee agreed on several directives:

- Laboratories: Continue renovations of Building 1 as a priority and replace research Buildings 2, 2A and the laboratories of 24;
- Security Center: Modify circulation to improve vehicle screening;
- Entrance Pavilion: Create new entrance pavilion for the conference center and parking for visitors without vehicle screening;
- Campus Center: Create a campus center by renovating Building 24;
- Prioritize connectivity between buildings, especially research facilities;.
- Administration: Consolidate management resource offices with support services;
- Support Services: Consolidate maintenance shops, garage, storage and related staff;
- Circulation: Remove center road; maintain loop road & vehicle connectivity;
- NOAA: Plan for National Weather Service labs as an expansion of Building 34;
- Small Buildings: Remove when replaced (1C, 1D,2A, 3A, 4,5 21,25,91,111,112, 131);
- Phasing: Swing space will be assigned in Building 1 for some Building 2 occupants, allowing phased demolition and replacement of Building 2.

Concept Evolution

The Master Plan concept was developed to be the organizing element of the disorderly assemblage of facilities on the DoC Boulder Campus. While groups of buildings within the campus have geometric relationships, there is no overall organization or relationship between the eastern and western groups of buildings. The concept's campus green provides a unifying pedestrian zone sweeping from Broadway toward the base of the Flatirons.

The Radio Building 1, fronting Broadway, is a highly structured research facility organized along a central spine with wings that create a rigid geometric grid of which Building 81 is the latest addition.

As needs arose, other facilities were added to the campus and constructed as individual buildings arrayed on the slope to the west. While there appears to be no relationship between those structures, study reveals that they actually share a common underlying geometry—but not related to that of the Radio Building.

The challenge of the new Master Plan is to bring unity to the entire campus by judicious location of new and replacement facilities so that the disparate geometries merge, connectivity is established, interaction is fostered, and new opportunities arise for members of the community.

Implementation of the concept is initiated as the Research Building replacement is implemented. A major new research building assumes the geometry of the Radio Building as it latches onto The Katharine Blodgett Gebbie Laboratory, Building 81. The building assumes a gentle curve as it sweeps westward up the hill, bringing it into a dialog with the underlying grid of the independent buildings and resolving the clashing grids. As the curved building extends up the hill its mass defines the northern edge a new auto free campus greenway for pedestrian and bicycle activities. Additions to Buildings 3 and 24 follow and define the southern edge of the greenway.

Exhibit 50: Existing Site

Exhibit 51: Existing Site Geometry

Exhibit 52: Master Plan Geometry

5 Landscape

This master plan envisions a connected and integrated campus park that links existing buildings and new with a central pedestrian promenade and campus green. This linear arrangement holds together a series of outdoor spaces--both grand and intimate. Instead of fragmenting social connectivity and environmental function, this corridor does the opposite: it animates social spaces and creates a highly functional green infrastructure. A unified palette of materials expressive of the local ecology and place provide thematic links across the entire campus.

5.1 Landscape Master Plan

Overall Approach: Reflecting a Sense of Place

One of the great assets of the NIST campus is the stunning backdrop of the Flatirons and the Rocky Mountain foothills. Instead of turning its back to this setting, this master plan embraces the best aspects of the place: the warm colors and rugged durability of the stone and trails; the room-like enclosures of clustered pines that open into wide expanses of grasslands, and the resiliency and beauty of the native vegetation. Embracing the materials and patterns of this landscape will not only result in a campus more visually integrated into its

Thomas Rainer

setting, but also reduce some of the most time and resource intensive maintenance for the campus.

Description of Major Design Features & Themes

The Campus Green and Central Promenade

One of the primary goals of this master plans to create a pedestrian "greenway" that is an alternative to the existing parking lot-driven campus. In addition to its role as a multi-modal network, the proposed corridor integrates a range of social spaces and green infrastructure into the physical design.

The central organizing element of the proposed design is a pedestrian promenade--a single unifying gesture--that connects Building 1 on the north end of campus all the way to Building 4 on the western edge. This promenade is a shared, multi-modal zone. The promenade provides a coherent link across campus: the continuity of paved surface, the expressive quality of trees and ground-layer plantings, and consistent palette of paving and furniture provide thematic links across the site. To allow for emergency vehicle access and bicycle use, the width of the transit way shall be fifteen feet Surface treatments should differ from that of a traditional road, signaling to users that this zone is pedestrian (see Hardscape Guidelines for more detail).

The Activated Campus

Land that currently surrounds buildings is primarily passive lawns and landscaped zones. A focus of the proposed redesign is the activitation of outdoor spaces. This is accomplished by providing for a wider range of social spaces and recreational amenities clustered along the central pedestrian spine.

The linear corridor supports a gradient of social spaces, from large public open spaces to intimate private spaces. Each space is designed to provide for the mobility, comfort, and amenity of its users. Three different categories of social spaces are featured in the design: large, medium, and small. The largest of these spaces includes the central lawn. In the current campus, lawn surrounds the perimeter of buildings, but is rarely used. The proposed plan inverts the location from passive perimeter spaces to a central, quad-like space framed by buildings and native vegetation. Benches, trees, and flexible adirondack-style seating help to encourage use. A number of sports and games can be played with minimal facility requirements. These include bocce courts, frisbee, a walking loop, and soccer.

In addition to the lawn, a large tree-covered plaza and deck anchors the center of the campus green. This space is envisioned as the social hub for the campus. A bosque of deciduous trees rising out of decomposed granite terrace provides an organizational framework and comfortable shady spot that humanizes the scale of the space. A large water feature helps to animate the space. Moveable tables and chairs allows users to take advantage of sun or shade depending on the time of year.

Another large-scale, multi-use space is the paved entry court located just off Building 81 and the main entry drive. Functionally, this space allows cars and emergency vehicles access to Building 81 and the campus green. But this space doubles as a pedestrian plaza, and can be a flexible space to

Exhibit 53: Examples of Campus as Activated Social Spaces

Thomas Rainer

Exhibit 54: Overall Landscape Master Plan

accommodate intermittent or short-term events like lunchtime food trucks, guest chefs, farmer markets, technology exhibits, barbecues, and other outdoor gatherings. The space may be supplemented with temporary structures like tensile canopies or pop-up tents that would be stored when not in use.

These large gathering spaces are complemented with a range of medium-sized spaces. Each building that faces onto the campus green features a graciously sized terrace, a place to eat lunch outside or take a quick break from the laboratory or office. Finally, a range of more intimate spaces such as benches and picnic tables should be scattered along the central promenade or in more private area underneath a cluster of trees.

Arroyo: Integrated Stormwater Management

This design proposes a large vegetated arroyo that parallels the central pedestrian promenade. The arroyo functions as an attractive, character-defining feature that also channels, slows, and filters stormwater off buildings and roads that currently sheet flows across acres of lawn and parking lots. The goal of this design is to create the appearance of integrated, ornamentally beautiful stormwater facilities that defines the character of the corridor. To that end, stormwater strategies shall be designed to look like ornamental planting elements, integrated into the geometry of the site. The arroyo will be designed to manage the flow, with a series of check dams that store and release stormwater slowly.

Pedestrian bridges and decking traverse arroyos both large and small, providing the opportunity to overlook newly dramatized ephemeral rain events.

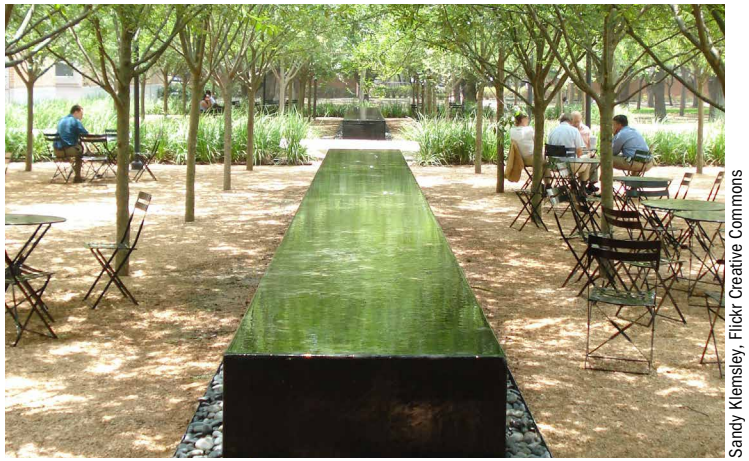
Visitor Entry Landscape

As the public face to the NIST campus, the landscape surrounding the future conference center shall be express the ceremonial character of the building. Graciously sized paths with lighting and signage connect visitors from the parking lot and Broadway to the building. The plantings are a combination of lawn, informal clusters of trees, and low native grasses with heavy drifts of flowering perennials, a more stylized and ornamental version of the native grassland plains community.

Exhibit 55: Example of Central Promenade

Ten Eyck Landscape Architects, Adam Barbe

Exhibit 56: Example of Tree-Lined Plaza with Water Feature

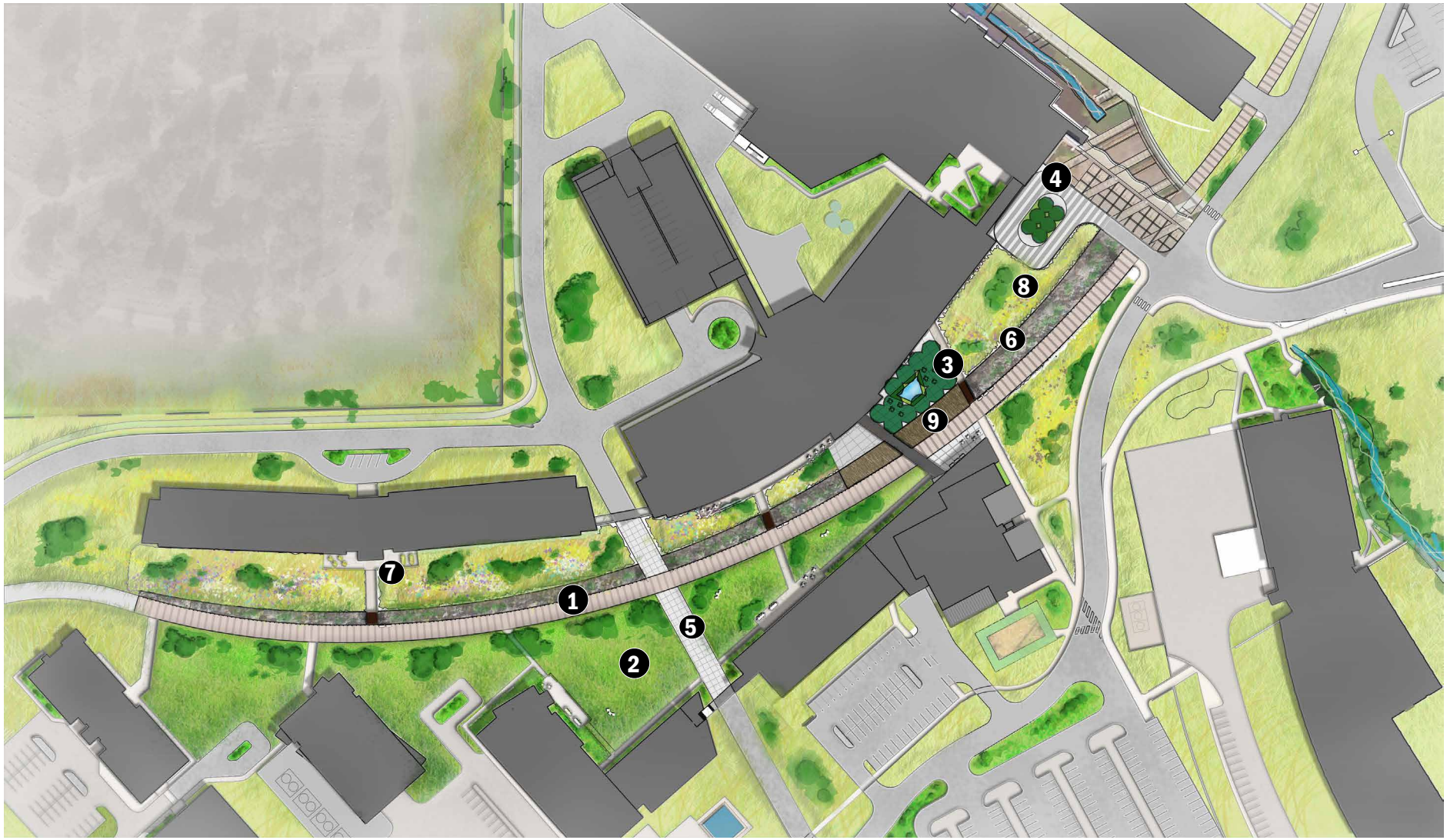


Sandy Klemsley, Flickr Creative Commons

Exhibit 57: Example of Arroyo

Liz West, Flickr Creative Commons

Exhibit 58: Campus Green Enlargement



Legend

1. Central promenade
2. Central lawn
3. Terrace with bosque of trees, water feature
4. Entry court
5. Shared street
6. Vegetated arroyo (stormwater management)
7. Building terraces
8. Active recreation space/ sports courts
9. Decking over arroyo

Design Language

The design language for the corridor is a blend of two distinct but compatible themes. The first is the emphasis on contemporary design aesthetic that expresses the technological mission that is at the heart of the agency. The second is a naturalistic aesthetic for all the "soft" features of the campus that emphasizes the natural setting with ecologically functional plantings.

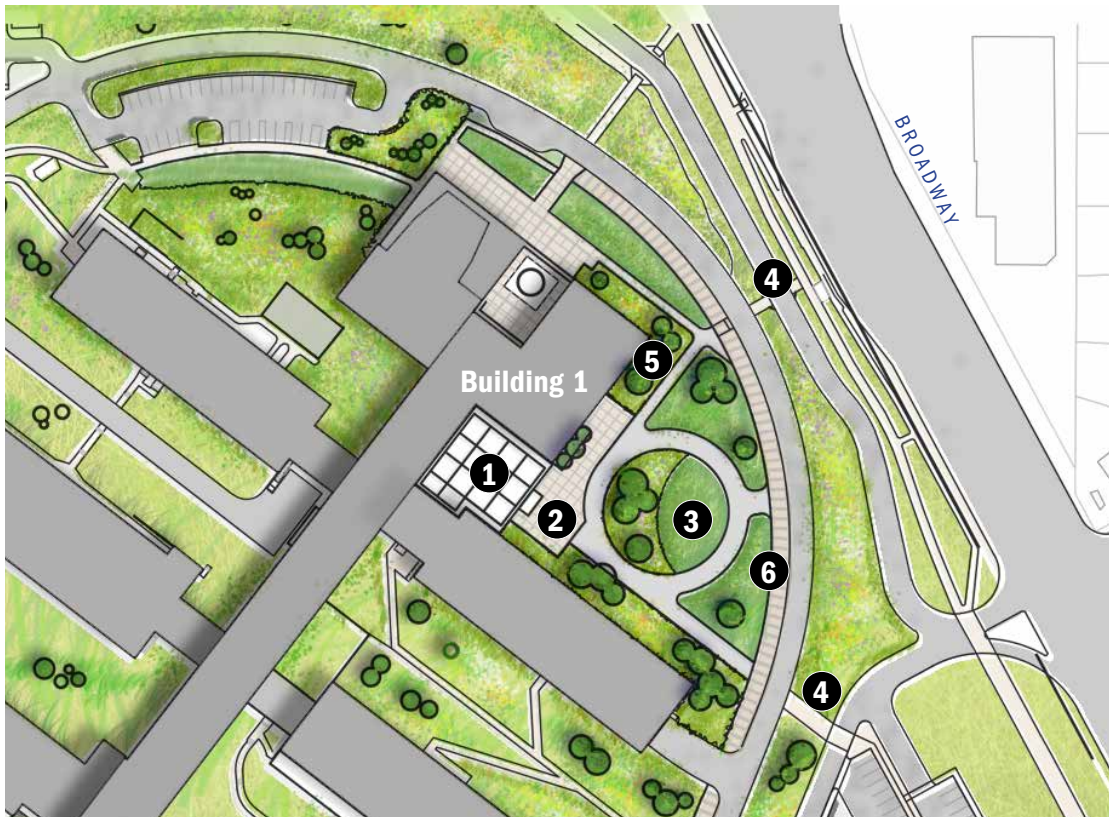
Contemporary Rustic Design Aesthetic

The first theme is based on an intentionally modern design aesthetic, but incorporates materials with less refined or rustic qualities. This aesthetic is visually compatible with the mountain setting that surrounds the campus. A contemporary design language reflects an aesthetic using bold structural forms; minimal detailing that emphasizes only the most essential connections, fittings, and unrefined materials. Detailing is minimal, forms are simple and lines are regulated but imprecise. Materials are close to their natural state with little or no refinement. Where possible, surfaces are unpainted and allowed to weather with only limited maintenance. Materials that are recycled or that can be recycled are incorporated where possible. Some examples of materials that meet these qualifications include: unit pavers in earthy and warm colors, cast-in-place concrete, asphalt, crushed stone, and rusticated steel. This rugged palette of materials can be animated by the placement of some of the technological innovations of the campus featured and interpreted in the landscape, celebrating the achievements and mission of the agency.

Framed Naturalism

This concept is influenced by the need for the corridor to provide a serene planted environment for the users and to reduce

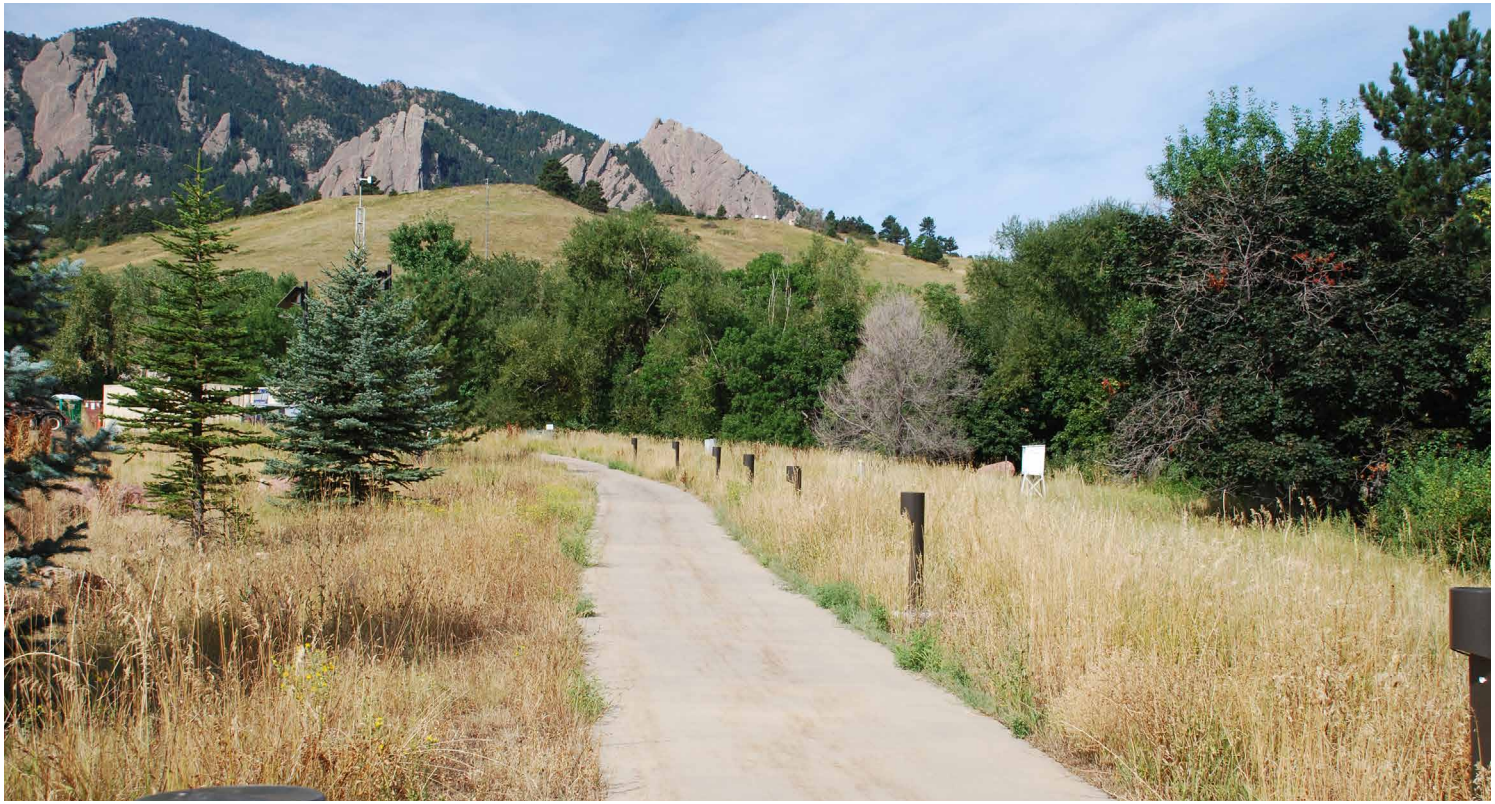
Exhibit 59 : Conference Center



Legend

1. Visitor pavilion
2. Entry terrace
3. Lawn
4. Walk to parking/bus
5. Ornamental planting
6. Central promenade

Exhibit 60: Design Language—Contemporary Design Surrounded By a Naturalistic Context



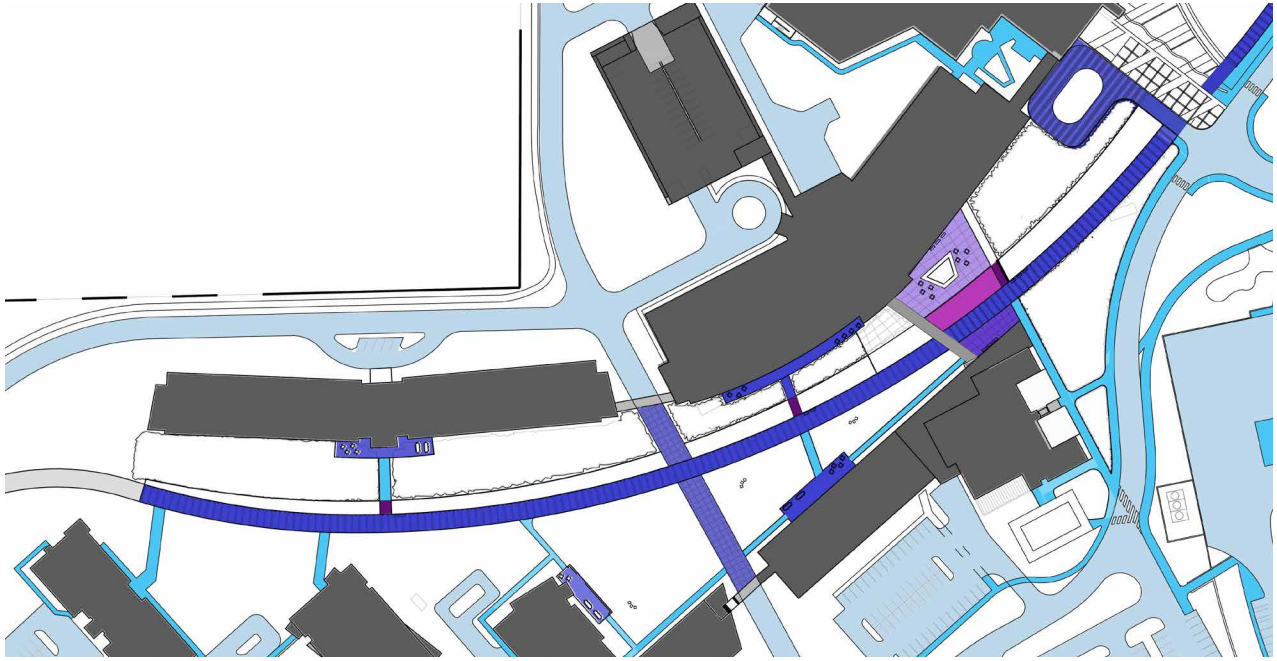
Thomas Rainer

Examples

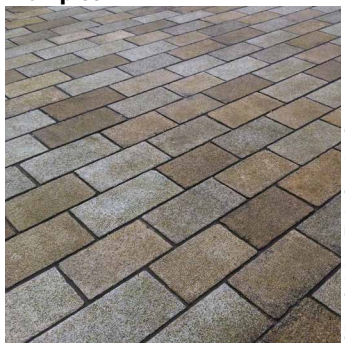
Ten Eyck Landscape Architects

PWP Landscape Architecture, Frank Farm, Flickr Creative Commons

Exhibit 61: Hardscape—A Unified Palette of Simple, Durable Materials in Harmony with Natural Setting



Examples


Oliver Quinlan, Flickr Creative Commons

Unit Pavers


NACTO, Flickr Creative Commons

Shared street


Leo Kraig, Flickr Creative Commons

Concrete


William Warby, Flickr Creative Commons

Crushed stone


James Stuart, Flickr Creative Commons

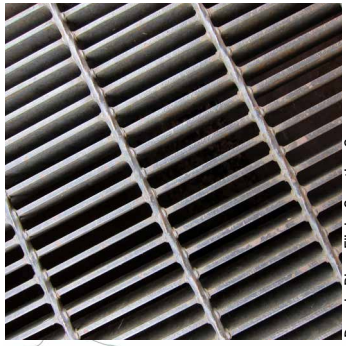
Asphalt


Thomas Rainer

Local stone


The Bywaters, Flickr Creative Commons

Weathered steel


Dennis Play, Flickr Creative Commons

Metal grates for footbridges

the use of resource-intensive lawn on the campus. The theme of framed naturalism emphasizes use of low native grass plantings that are framed by paths, buildings, and lawn. Framing naturalistic vegetation helps it to appear neat and related to the campus context. For example, placing a mown lawn verge or a sidewalk against the edge of low grasses makes it look more ordered and intentional. Informally arranged clusters of pines and cedars, low native grasses, and vegetated stormwater plantings are all important form-giving elements of the campus, providing a lush counterpart to the hard-edged built features.

Hardscape

The design language for the hardscape is inspired by the warm colors and rugged durability of the natural stone and trails that surround the site. A combination of natural materials such as stone, gravel and crushed stones combined with durable constructed materials like corten steel, poured-in-place concrete, and unsealed asphalt all help to create a unified campus in harmony with its context. The use of materials and finishes that do not require frequent maintenance or repair is a priority. The rustic character will permit a high degree of weathering and wear before elements appear neglected. Cast-in-place concrete structures can have a rough-hewn appearance depending on the type of form work and finishing applied. The irregularities that appear in the surface of the concrete are desirable in the rustic vernacular. This design language is further expressed in these principles:

1. Use Maintainable, Durable Materials: Use cost-effective materials such concrete with saw-cut joints, unit pavers, stone, crushed stone, and asphalt.
2. Use Consistent Colors & Patterns: A consistent color palette of warm grays (in varying hues), browns, and rusticated steel provides a range of colors that are easily available across a range of materials.
3. Vary Materials to Express Site Hierarchy: Different hardscape materials can express the hierarchy of spaces and pedestrian circulation, integrating wayfinding into the design itself. For example, the central promenade may use unit pavers in with a strong graphic pattern such as stripes while sidewalks and other secondary circulation can use scored concrete.
4. Mix Hard and Soft Materials to Reduce Scale of Large Paved Spaces: Break up large expanses of hard paved areas with crushed stone joints, edging, or seating areas.

Site Architectural Elements

The repetition of several distinctive small-scale landscape architectural elements can enrich the campus's sense of place. Examples include low footbridges that cross the vegetated arroyo and create thresholds into different site zones, trellised walks that emphasize main circulation routes and provide shade on hot days; and shade sails or canopies that distinguish small and medium-sized terraces. The materials for all of these vertical elements shall be similar across the campus. Materials like rusticated steels, wood, or stone are appropriate options.

Furnishings

Furnishings should follow the contemporary- rustic design aesthetic, with a focus on contemporary forms and bold sculptural elements. A mostly neutral color palette is recommended, (warm grays, earth tones), with selective use of a bright color accent. Durable materials including concrete, cast stone, and stainless steel should be used.

Exhibit 62: Providing shade is an important consideration for activating public spaces.

American Shade Sails, Flickr Creative Commons

The recommended palette of site furnishings supports a range of functional and recreation uses. They should be used to create a dynamic and inviting outdoor environment that reinforce the hierarchy of social spaces Flexible furniture shall be prioritized, including low walls that double as benches or moveable tables and chairs.

Signage & Wayfinding

Many of the master plan's recommendations focus on clarifying the circulation on campus by providing centralized spaces, more direct connections, and a clear hierarchy of spaces and paths. All of these design elements will help pedestrians, cars, and bicycles navigate the campus. In addition to the physical design itself, this plan recommends developing a cohesive wayfinding plan. Fully integrate signs with other disciplines, including architecture, interior design, lighting, landscape architecture, roadways and parking. Merge signage into the existing vocabulary of site materials and into the architecture and site itself, making signs present and readable, yet unobtrusive. Create designs that convey a positive visual image to all viewers and sense of identity for the campus.

Lighting

The design of site lighting must address several key factors. First, lighting levels must be adequate to meet safety and security requirements, while meeting the highest and best sustainability requirements for light pollution reduction (LEED and federal requirements for Dark Skies and City of Boulder Outdoor Lighting Ordinance). Second, lighting fixtures must be energy-efficient and should require minimal maintenance. Finally, light fixtures should be compatible with the design language and should be integral to the family of site furnishings or be designed through the public art process. Use the following types of lights and fixtures:

1. Utility lights: Existing campus pole lights for vehicular zones such as roads and loading docks.
2. Feature lights: Clustered arched poles with multiple fixtures can help to mark main plazas and entry court.
3. Bollard lights: Low-level pedestrian lighting that create wayfinding along the pedestrian promenade.
4. Place-making lights: A range of different ambient lighting such as string lights in trees or bench lighting that activate.

Exhibit 63: Examples of Furnishings

Santa Cole for Landscape Forms

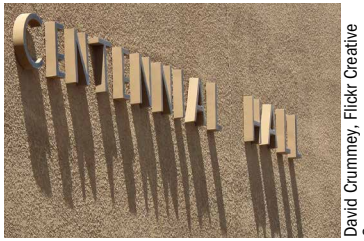
Santa Cole for Landscape Forms

Landscape Forms

Sandy Klemsley, Flickr Creative Commons

Exhibit 64: Examples of Signage and Wayfinding

Calori & Vanden Eynden, Flickr Creative Commons



David Crummey, Flickr Creative Commons

Vincent Q, Flickr Creative Commons

Exhibit 65: Lighting

Examples

Existing solar utility lights

Thomas Rainer

Feature lights

Escofet for Landscape Forms

Bollard lights

Artform urban furniture

Place-making lights

Matthew Gilbert, Flickr Creative Commons

Outdoor charging stations

Legrand for Landscapeforms

Planting

The foothills surrounding the campus are predominantly a Ponderosa Pine woodland/grassland. Not only is this ecosystem resilient and adaptive, it is also a highly legible and attractive plant community. The room-like quality created by the scattered clusters of trees, under planted with a sea of golden grasses--is a vegetative model of human-scaled spaces, making them an ideal inspiration for a campus landscape.

This master plan envisions replacing much of the water-intensive lawns that currently surround campus buildings with low grasses and clustered evergreens characteristic of Colorado woodlands vegetation. The way this vegetation gets applied to different parts of the campus will vary depending upon the context. Planting should be understood as a gradient between natural and cultivated zones. The same core plant palette and patterns will unite all of these zones, but be applied differently. For example, planting areas on the Mesa and the far edges of the site shall be the most naturalistic, relying on purely native plants and management techniques meant to preserve the integrity of the community. As the plantings get closer to buildings and major pedestrian gatherings, a more stylized version using some of the more ornamental native selections and cultivars may be used to relate to that context.

Gradient of Vegetative Zones

Creating a subtle gradient between the wild landscape surrounding the campus and the structured spaces of the campus itself is a key principle of this master plan. Three different vegetative zones are proposed here. Along the perimeter of the campus, a predominantly native zone is recommended. This zone would not be irrigated, so it would rely on clusters of pines and junipers which could be used for screening parking lots and adjacent neighborhoods. Two additional zones are envisioned for interior spaces between buildings. These more structured zones would still use native species, but the arrangement of the plantings would be more formal and structured. The diagram on the following page describes the placement and principles of each zone. Several guidelines are important for establishing this native-type vegetation:

1. Use a high percentage of visual essence species: To relate the cultivated plantings to their natural inspirations, it is important to use large quantities of those plants that dominate native woodlands. Trees such as Ponderosa Pines and Rocky Mountain Junipers are critical components of the canopy layer. Grasses such as mountain brome (Ceratochloa carinata), needle and thread (Hesperostipa comata), green needlegrass (Nassella viridula), and mountain muhly (Muhlenbergia montana).
2. Make the patterns visible: In order to make the natural patterns of the woodlands visible, it is important to create tighter, denser, and more exaggerated versions of the original. For example, if wild asters form loose drifts through a field of grass, then creating a thicker mass of five or seven asters will create a more robust, readable version than what happens in the wild.
3. Restrain the height of plantings: Keeping grasses low (18-36") is an effective way to fit naturalistic plantings in campus contexts. Being able to see over mass plantings makes them more legible and appreciated.

Structured and Ornamental Planting Zones

In plazas and other heavily trafficked areas, the patterns of the planting can become more structured and ornamental. A grid of deciduous trees such as hackberry (Celtis occidentalis), honey locust (Gledistsia sp.), maples (Acer sp), oaks (Quercus macrocarpa), or western birch (Betulus occidentalis fontinalis--requires irrigation) may provide an architectural relationship to a building's courtyard. On the ground plane, this zone may use a heavier percentage of flowers interspersed into the matrix of ground covering grasses. Wildflowers of the genus Aster, Penstemon, Liatris, Echinacea, Monarda, Helianthus and others are appropriate here..

Exhibit 66: Grasslands Planting at NCAR Campus

Thomas Rainer

Exhibit 67: Planting zones

Zone 1: Native

Thomas Rainer

Native plants of the Boulder foothills woodland/grassland ecosystem

Where: Edges and large scale open spaces on campus

How: Landscape management techniques aimed at preserving stability of community

Zone 2: Naturalistic

Sarah Price & James Hitchmough

What: Native species, native cultivars, and adaptive plants selected for their ornamental value. Higher percentage of flowers and native deciduous trees

Where: Spaces around perimeter of buildings, edge of campus green

How: Minimal maintenance focused on keeping ground covered

Zone 3: Structured & Ornamental

Thomas Rainer

What: Native and adaptive plants arranged in formal patterns

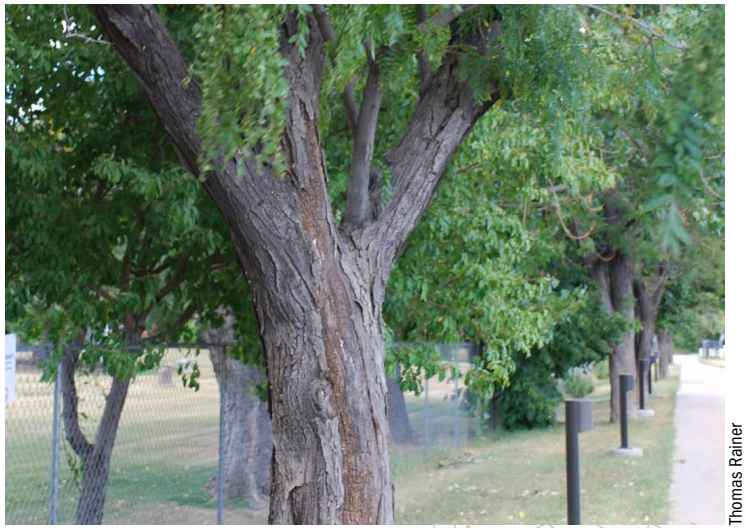
Where: Central gathering places, terrace, courtyards between buildings

How: Medium maintenance focused on preserving design gestures

Care and Maintenance of Ash Trees

The normally prescribed method of Ash Tree prevention from Emerald Ash Borer is application of chemical insecticide. There are four methods of application: soil injection, trunk injection, lower trunk spay, and spray that encompasses trunk, branches, and foliage. While these methods provide prevention of EAB invasion, it is only on a temporary basis and dependent on vigorous tree health before application. Insecticide will have to be repeatedly applied to prolong protection from the invasion of EAB. The repeated and continuous application of chemical insecticide into the surrounding soil, and sprayed into the air around the tree can have detrimental effects to the neighboring environment. For these reasons, the best method of preserving the deciduous tree population on NIST Boulder's campus is diversifying the canopy. Over time, Ash Trees should removed and replaced. Other native deciduous species like Narrowleaf and Plains Cottonwood, Balsam Poplar, and Peachleaf Willow should be introduced to the site to maintain deciduous foliage should the Ash Trees become invaded by EAB.

Exhibit 68: Ash Trees Around NIST Campus



Thomas Rainer

6 Utility Framework

The Central Utility Plant (CUP) provides chilled water, steam and compressed air to most of NIST's laboratory buildings, distributed through a tunnel system running from the CUP to mid-Building 1, with services branching off the individual buildings. These systems are in good condition, and will be extended to the new and renovated NIST laboratory buildings in the Master Plan. The Childcare Center may be provided with dedicated heating and cooling systems independent of the campus systems or alternately connected to the campus steam and chilled water system because of its close proximity to the CUP. Certain other planned buildings—NOAA Laboratory and the Security Center—are not near the CUP or utility tunnel and should be provided with dedicated independent heating and cooling systems. Normal electrical power and data communications services should be extended from the campus distribution systems. Note that NOAA buildings do not use the services of the CUP.

Building 1 Renovations

Building 1, the largest building on campus will remain in its current form and function under the Master Plan. Complete renovation is planned for Wings 1, 2, 4 and 5 along with the spine. At present some wings are undergoing some level of construction activities, but a review of the available documents indicates that there is not an overall utility infrastructure plan guiding the various renovation efforts. A plan should be developed that clearly outlines the approach to primary utilities including steam and chilled water from the central plant and their distribution within Building 1 complex. Similarly, common systems such as heating hot water system and process cooling water system, should have a consistent plan for generation and distribution within the building. The main mechanical room in the basement, coupled with the spine for distribution to the individual wings, would be a logical approach to generation and distribution of key common utilities. Air handing systems should be dedicated to each wing as currently done in Wings 3 and 6.

The existing electrical distribution systems in areas not under renovation are antiquated and at the end of their service lives. Continued reliable operation of both the liquid-filled medium voltage distribution transformers and the low voltage switchgears will be challenging due to the unavailability of spare parts. Also, emergency back-up power is not readily available in these wings to support the state of art research facility expectations defined by NIST laboratory classifications. As part of the overall plan for the Building 1 renovation, replacement and upgrade of normal and standby power system should be prioritized.

Renovation of the building should also include the complete installation of fire sprinklers throughout all areas. The current renovations of wings 3 & 6 include a separate fire and domestic water service to each wing. This is a reasonable approach and should be carried forward in future renovations. Replacement of existing sewage ejectors that handle the lower levels of the wings is also suggested, as the older systems are near the end of their useful life. All domestic water and lab water supply piping has been modified many times and any new renovation should include complete replacement of the piping in the renovation area. The same is true for sanitary and lab waste piping. A new sanitary lateral should exit the building at each wing and tie into the site sanitary sewer system. Separate metering of all utilities to the building at each wing will provide an opportunity to monitor and fine tune efficiencies and consumption.

Visitor Pavilion—primary utilities for the addition of the new entry pavilion should be extended from the main systems

serving Building 1. The entry pavilion should be provided with dedicated air handling systems and general power and data distribution as required Proposed design subject to Section 106 Consultation with Colorado SHPO.

Building 3

Building 3 is currently under renovation. The building is served with steam and chilled water from the CUP, with electrical power provided from the campus distribution system. The planned later lab addition to Building 3 will require relocation of the existing duct bank to clear the proposed foot print of the addition. Steam, chilled water and electrical power (normal and standby power) should be extended from the existing campus distribution system to serve the new addition. The addition should be provided with dedicated air handling systems, power and data distribution to support the program.

New Research Buildings

The new research buildings should be provided with steam and chilled water service from the utility tunnel. Normal electrical power and data communication services should be extended from the campus distribution system. Standby power should be provided via local dedicated diesel generators. Design criteria for NIST general purpose research laboratories are grouped under three laboratory types—L1, L2 and L3. L1 laboratories require the least or lowest level of environmental controls, while L3 labs provide a much more precise levelof environmental controls. At this time NIST anticipates that the new labs will follow the criteria for type L2, with the potential to upgrade. This criteria should be used for planning of laboratory spaces and utility distribution. Primary mechanical, electrical and plumbing equipment should be sized and arranged with redundancy such that if any major equipment fails or is out of service, the remaining equipment can support the laboratory demands without compromising function. Modular layout and distribution should account for long term flexibility allowing easy accommodation of changes in use within the same laboratory types. Laboratories should be zoned for energy and operational efficiency such that lighter duty labs that may use recirculating air systems are grouped together. Similarly, chemical and fume hood intensive laboratories requiring 100% outside air systems should be zoned together. Hybrid air/water cooling systems (such as chilled beams) should be considered for equipment and instrument intensive laboratories. Special attention should be provided in the electrical distribution system with regard to power quality. Piped utilities such as compressed air, vacuum, high purity water distribution should generally follow the modular arrangement to maximize flexibility. Special laboratory gases may be provided by local sources such as generators or cylinders with local distribution.

Prior to construction of new laboratory buildings to the west of Building 81, a portion of Building 2 will need to be demolished leaving the northern most section of the building (1964 construction) to remain for continued occupancy. The existing mechanical (steam and chilled water) utility entrance from the main tunnel will be impacted by the portion of the building that needs to be demolished. Further, the primary air handling system along with electrical service serving the 1964 construction is located in the penthouse mechanical room, in the portion of the building to be demolished. Therefore, temporary dedicated mechanical, plumbing and electrical systems need to be provided for the 1964 area of Building 2 prior to demolition. This will allow continued operation of existing functions in the 1964 area. In addition, prior to construction of the new laboratories, site electrical duct banks and manholes and communication duct bank and manhole in this area should be re-routed to clear the proposed foot print of the new laboratory buildings. After completion of the laboratory buildings, it is planned that the remaining section (1964 area) of Building 2 will be vacated and demolished.

Campus Center

Existing Building 24 is served by the central plant steam and chilled water systems. The primary pumping systems and heat exchangers are in poor condition. Two of the three air handling units serving the building, located in the basement mechanical room, have also exceeded their useful life. A third air handling unit located in the penthouse mechanical room appears to be a more recent installation and may be evaluated for re-use in the new Campus Center if functionally feasible. The main electrical room is located in the basement of Building 24. There are two separate electrical services, one active and one abandoned. The medium voltage transformer and low voltage switchgear are beyond their useful service life. The plumbing systems are largely comprised of the original equipment and piping and have little residual value. The existing building is not fully sprinklered.

The new Campus Center should be provided with properly sized upgraded services from the campus utility distribution system for steam, chilled water, power, data, water and sewer. New air handling systems should be provided and zoned to match the various functional requirements of the Campus Center. New service transformers, switchgear and power distribution system should be provided along with a new generator for life safety loads. Collaboration spaces, food service areas and other gathering spaces should be provided with technology systems capable of handling higher density usage.

All engineering systems must be evaluated and integrated with the architectural systems to achieve the goal of LEED Gold Certification.

Management Resources Center

The Management Resources Center, with its office and support functions, has the potential to be a very energy efficient building—net zero energy consumption, certified LEED Gold or higher and meeting a maximum Energy Use Index of 25 kBtu/sf-yr. Considering that this building replaces several aged and inefficient buildings with energy system efficiencies that are well below modern standards, a high performing modern building will result in significant net energy and cost savings to NIST. Inclusion of the central computing center in the building, under consideration, may make the net-zero goal difficult or impractical. Alternatively, the central computing center may be included in the research building project, depending on the phasing.

The building may be provided with dedicated heating and cooling systems independent of the campus systems or alternately connected to the campus steam and chilled water system due to the close proximity to the CUP. Standby power should be provided via a local dedicated diesel generator. Prior to construction of this building, the existing electrical duct bank and manholes should be relocated/re-routed to clear the proposed foot print of the new building.

Central Utility Plant

Under the master plan, the following buildings are proposed to be connected to the central plant steam and chilled water system:

Exhibit 69: Connections to the CUP

Building	Steam	Chilled Water
Building 1	x	x
Building 3	x	x
Building 42	x	x
Building 81	x	x
Management Resources Ctr.	x	x
Replacement Laboratories	x	x
Building 3 Addition	x	x
Campus Center—Building 24	x	x

Based on conceptually estimated heating and cooling loads (approximately 4,500 tons of chilled water and 65,000 PPH of steam), the central plant has the capacity to support the buildings proposed under the master plan. This is based on the assumption that the chilled water system is capable of producing the design output of 1,500 tons per chiller (6,000 tons total for the plant). In addition, as outlined in the building design guidelines, HVAC systems should be provided with sustainable features such as exhaust air energy recovery, decoupled ventilation/cooling (chilled beams), etc.

In addition, as part of the construction of new buildings and parking structures, roof mounted photo-voltaic systems integrated with the building power system should be considered.

Campus Electrical Power

The total built area under the master plan is approximately 1,015,000 sf (excluding NOAA buildings, which are on a separate system). Out of this approximately 746,000 sf of existing buildings are retained and renovated, while 269,000 sf new building/additions are planned. Current campus peak demand of 5462 kW (6,828 kVA) registered in July 2016 translates to about 7.7 VA/sf. This number appears to be low compared to industry benchmarks for comparable buildings. For planning purposes, we have assumed load densities of 12 VA/sf for new buildings/additions and 10 VA/sf for retained/renovated buildings. This results in a projected campus demand of 10,700 kVA (10.7 MVA). The campus is provided with two primary medium voltage feeders, each rated for 11 MVA. It is recommended that building load densities be monitored closely as buildings are renovated and new buildings are added to ensure that the feeder capacity and redundancy are maintained.

The existing medium voltage high-speed transfer switch is an issue to be addressed in the near term. The NIST Boulder campus electrical engineers report that the existing medium voltage high speed transfer switch is antiquated and the switch manufacturer will no longer provide hardware maintenance and support beyond the next two to three years. The medium voltage high speed transfer switch accepts two utility medium voltage feeders and distributes branch circuit feeders to campus buildings through a network of underground ductbanks and manholes. One utility feeder is active at a time and if out of service, the high-speed transfer switch will transfer the entire NIST Boulder campus electrical loads to the back-up utility feeder. The current high speed switch is designed to complete transfer within one cycle.

To replace the existing medium voltage high-speed transfer switch, three options were discussed with NIST Boulder electrical engineers. For all three options, the new electrical distribution equipment should be installed and commissioned before the existing equipment is dismantled to maintain continuity of electrical service on the campus. A focused study should further explore the following options, to determine the most appropriate solution considering reliability, performance and cost.

Option 1

Provide a new medium voltage distribution switchgear to accept one utility feeder and distribute branch circuit feeders to buildings on the campus. The advantage of this approach is that it is cost effective and simple to maintain. However, it will not provide the redundancy at the service entrance level.

Option 2

Provide a new medium voltage distribution switchgear to accept two utility feeders with a tie breaker. The switchgear can be arranged to have the tie-breaker closed to allow one utility feeder to serve the entire campus. The tie breaker and utility feeder main breakers can be controlled by either relays or a programmable logic controller (PLC). If the active utility feeder fails, the relay or PLC will open the failed utility feeder main breaker and close the main breaker of the back-up utility service feeder.

The advantage of this configuration is that redundancy of electrical service will be provided at the service entrance level. The disadvantage is that it will cost more than option 1, and require a larger footprint for the equipment. Also, the tie-breaker transfer typically takes four to five cycles, which is longer than the current one cycle transfer time.

Option 3

Provide a new medium voltage distribution switchgear to accept one or two utility feeders and a generator-backed uninterruptable power supply (UPS) as a back-up feeder for campus medium voltage power distribution. This medium voltage switchgear configuration would be similar to option 2, with the utility feeder serving the switchgear for campus wide distribution while the tie breaker is in the closed position. The main breaker of the generator-UPS power supply would be open. Upon detecting the utility feeder(s) has failed, the main breaker of the utility feeder would be opened by relay or PLC and the generator-UPS feeder main breaker would be closed to serve the switchgear.

The advantage of this approach is that ultimate reliable electrical service is provided for the NIST Boulder campus because the electrical power supply is completely independent of utility services. The disadvantage of this configuration includes the large foot print required, increased capital cost and long term maintenance cost of generator-UPS system.

Campus Water Systems

The campus domestic water system is connected to the City of Boulder water supply at four active locations. A fifth connection is currently not recording flow. The existing piping system is approximately 50% loaded and is in a loop configuration which provides an adequate level of system redundancy. The primary challenge with the domestic water system is the fiscal year 2020 usage goal which is approximately 55% of the current water consumption. Due to the age of the system, the recommendation is to line all existing pipes that can remain in service and not be impacted by the future growth. This will ensure going forward that any water main leaks will be eliminated conserving water. Regulations require that the campus significantly reduce water use and this will primarily occur through the following:

1. Reduce or eliminate the use of domestic water for irrigation. (In general, current irrigation utilizes Anderson Ditch water.)
2. Provide all low flow fixtures in all renovated and new buildings.
3. Eliminate all one pass cooling for any equipment.
4. Repair and line all underground pipe.

Exhibit 70: Proposed Water Distribution

Exhibit 71: Proposed Sanitary Sewers

Exhibit 72: Proposed Storm Sewers

5. Comply with "Best Practices For Municipal Water Conservation in Colorado".
6. Monitor the metering of the buildings versus the total campus flow to ensure there are no underground leaks.

The sanitary sewer collection system runs from west to east across campus and discharges at two outfalls. Based upon the domestic water loads and topographical features, the existing system is less than 50% loaded. Due to the age of the system, the recommendation is to line all existing pipes that can remain in service and not be impacted by the future growth. This will ensure going forward that any future maintenance will be eliminated conserving water

The campus storm sewer system collects storm water from the facility to discharge to Skunk Creek and Anderson Ditch. Under the master plan, the overall impervious surface is reduced, which should reduce the total stormwater flow somewhat. The arroyo in the Campus Green is proposed to manage the water that drains from the surrounding buildings and its release into the existing storm drain system, located at the east end of the Arroyo. This system ultimately flows east to the drainage system in South Broadway. The release rate and storage in the arroyo should be designed to not only manage the flows from the development, but also decrease flows below the current levels. A series of check dams at 75-100 foot intervals within the arroyo are proposed, to temporarily store and slowly release the stormwater. Stormwater from the upper half of the Arroyo would be directed to the Skunk River through the existing drainage system. From the lower half of the Arroyo it would be directed through the existing drainage system that flows to the front of the facility.

Currently there is a Stormwater Management Plan (SWMP) that NIST follows and maintains to comply with the requirements of National Pollutant Discharge Elimination System (NPDES) Permit No. COR042002 (MS4 Permit). For the Master Plan, new building structures will need to comply with the MS4 Permit in effect at the time of construction. It is recommended that a Comprehensive Stormwater Management system be created to manage the entire site. This will likely have two to four collection systems and be strategically located to enhance the landscape features on the site and meet the requirements of the local and state Best Management Practices. All upgrades shall be in accordance with the City of Boulder Comprehensive Stormwater Utility Master Plan, which includes the local and State of Colorado laws.

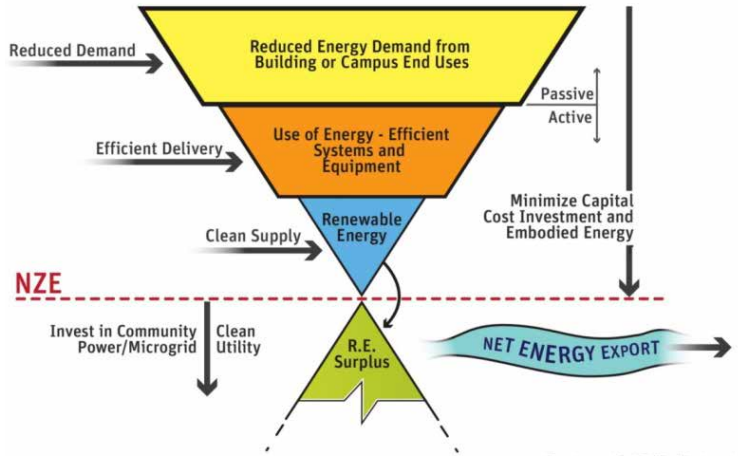
6.1 Building Energy Design Strategies

All high performance buildings are comprised of highly efficient systems and a design in which all systems have-been designed to work together as an integrated whole. Any given system will be designed to work synergistically with the other building systems. A high performance building is one in which the whole truly does operate as something greater than the sum.

The Management Resources Building and the Childcare Center are proposed to be net-zero energy buildings. The Campus Center also provides an opportunity for incorporating significant energy savings strategies. All new and renovated buildings shall be designed with energy efficiency to the greatest extent possible.

Design strategies and related technologies for all the new buildings and renovations should begin with optimization of the project program and design, and continue to evolve with the refinement of the program, architecture and budget. Design strategies described here are not exhaustive, and supplemental approaches may be necessary to meet the stated goals. Strategies should be chosen to meet the performance criteria of the building, and be supported with detailed analysis, documentation and ultimately proven out through field commissioning at the end of construction. The building design should employ both passive and active systems. The approach is multi-tiered:

Exhibit 73: Net Zero Strategy



1. First, reduce energy demand;
2. Second, choose energy efficient equipment and systems;
3. Third, provide a clean renewable energy supply.

Natural Ventilation. The location of the Management Resources Center with its temperate climate is well suited for natural and passive ventilation. The design should consider integrating both passive and natural ventilation into the building. In addition, ceiling fans should be provided along with nighttime flushing and additional thermal mass as required to maintain occupant comfort. The use of outside air filters for the passive ventilation strategy should be reviewed with NIST during the development of the design. Active mechanical cooling should be supplemental. Shop and storage areas can utilize natural ventilation, supplemented when using shop equipment. Natural ventilation could be considered for other new or renovated campus buildings, except for laboratory components that require more carefully controlled environments.

Improved Envelope. The design of the building envelope is not only a matter of aesthetics and basic enclosure, but also an opportunity to address various climatic and operational impacts on building energy and comfort performance. It is the intersection for aesthetics, solar radiation (heat gain and daylight), heat transfer, moisture transfer, visual connection, and natural air movement. As such, it is important to address the factors in an integrated manner.

A simple adjustment of either window to wall ratio or the solar heat gain coefficient can lead to significant cooling load increases in various space types. This in turn requires an increase in cooling equipment capacity (and often size). The increase can also be a limiting factor in the types of cooling systems that can address the loads effectively.

Design can alter space cooling loads through varying the window-to-wall ratio and solar heat gain coefficient (SHGC). The amount of glazing area also plays a key role in allowing daylight into the space. Useful daylight is that which provides illumination to the tasks occurring in the space without providing excess quantities that create glare discomfort. Thus, between window area and the visible light transmittance, a balance must be determined. This balance must also consider the impact on solar gains to the space which result in cooling loads. Often this balance between glare, useful daylight, and heat gain is only partially resolved, resulting in the use of

Exhibit 74: Window-Wall Ratios and Solar Heat Gain

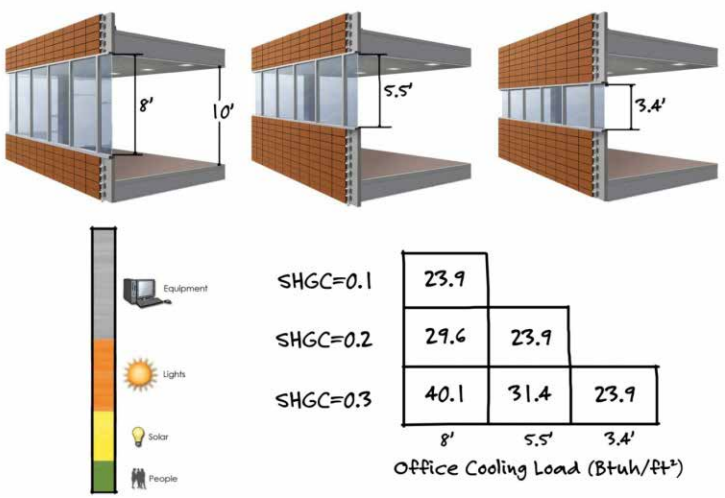


Exhibit 75: Electrochromic Glazing

internal shade devices. Another possible solution to explore is the use of electrochromic glazing. This technology uses a small electrical charge to change the glass from a "transparent" state to a "tinted" state along a continuum with operational steps between the two points. The advantage is that both the visible light transmittance and solar heat gain coefficient area dramatically lowered when in the tinted state, reducing glare potential and cooling load, yet there is still a visual connection to the outdoor environment, unlike with internal shade devices. The system can be controlled using solar time or solar radiation, and connection to the space thermostat can inform modulation of the dimming to offset any comfort heating demand.

The application of electrochromic or similar thermochromic glazing is most likely not cost effective or necessary in all areas of the building, but various target areas should be considered such as the east and west façades. In addition to these types of dynamic glazing, active external shading devices can provide similar benefit with a different aesthetic expression. In evaluating such envelope strategies it should be recognized that the building skin is an integral part of the building HVAC system and it is possible to reduce mechanical HVAC capital costs with such strategies.

Lighting Load Reduction. The Management Resources Center, the Campus Center and office areas within research buildings present opportunities to create outstanding and memorable buildings with reduced energy consumption. Lighting load reduction begins with the effective utilization of natural light. Design studies should maximize the potential for using natural light for most daytime general illumination, augmented by task lighting tailored to the activities. Natural lighting strategies must control glare, which is dangerous in shop areas and which can prompt office workers to close the shades/ blinds, negating the environmental and energy benefits. Considerations include orientation, window height, shading devices, daylighting controls on ambient lighting.

To successfully meet the energy goals, the electric lighting systems must be designed to incorporate highly efficient technologies, maximizing illumination while reducing glare or veiling reflections, e.g. dimmable LED light sources. The intensity of light should be accurately tailored to the task requirements of the users, with little or no excess capacity. Key components should be developed to form a comprehensive strategy which unites various spaces within the building to create a consistent light character and quality of light. The solutions to be

Exhibit 76: Office Lighting Strategy

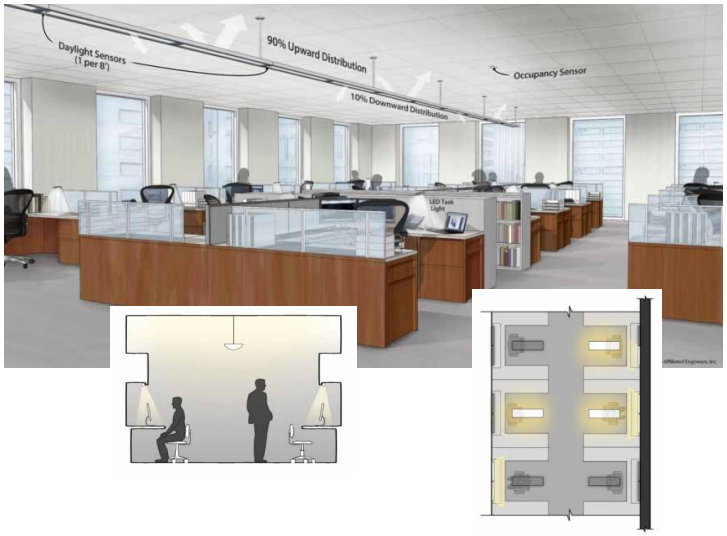
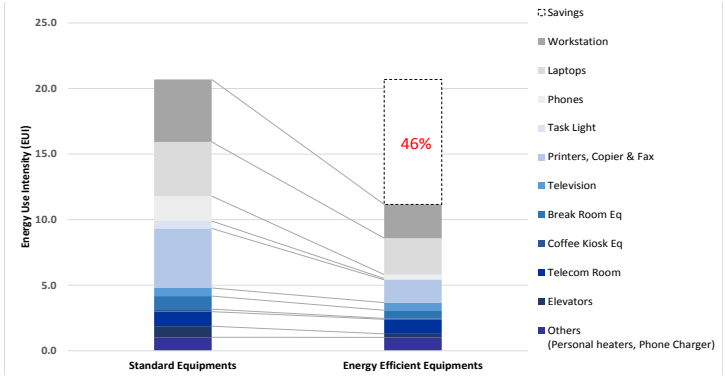


Exhibit 77: Plug Load Reduction



developed should integrate light within the form and structure of the space to clearly communicate function and the relationship of the lighting to the larger architecture of the building. Comprehensive control systems should be employed to maximize the benefits of day light, turn off lights when spaces are un-occupied, and reduce lighting after hours. These should be selected to maximize simplicity within spaces while still providing the highest level of controllability.

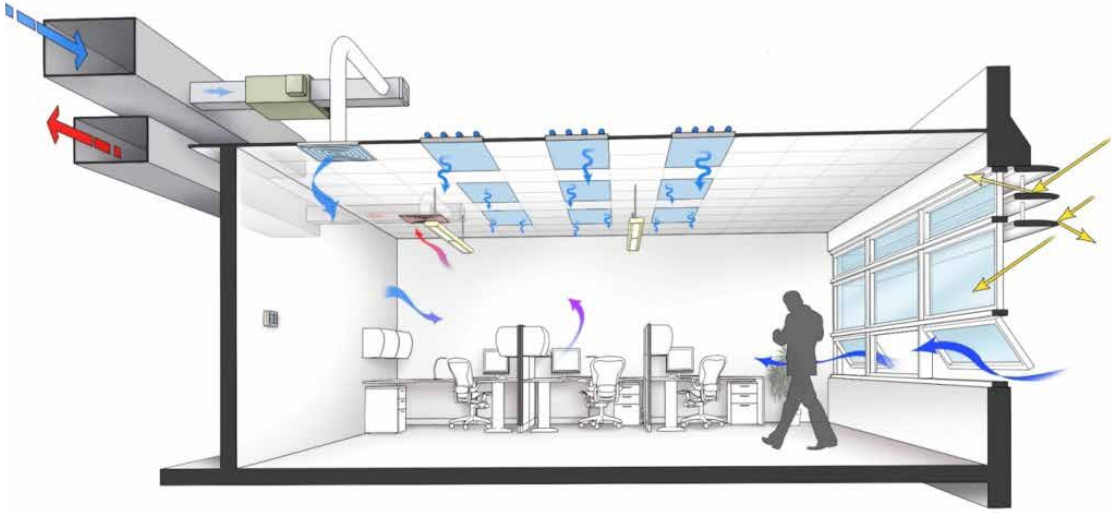
Plug Load Reduction. Purchasing more efficient equipment is the most direct way to reduce plug loads. Equipment with energy saving features may or not have a higher associated first cost. When older, less efficient equipment is being moved into a new building from other facilities, effort should be taken to replace or upgrade those inefficient devices. Intelligently controlling equipment also can lead to reduced energy use. Some equipment can be controlled via occupant-sensing technologies. Examples include fume hoods, computer monitors with occupant sensors, banks of equipment linked to room occupant sensors, etc. Where possible, shared occupant sensors linked to multiple pieces of equipment can help to reduce first costs.

Air-side Energy Savings. The use of air distribution can be an efficient means to provide cooling if the system is designed well and takes advantage of the climate opportunities of Boulder. The requisite amounts of outside air supplied to the office and support spaces is based on the number of people in each space. In order to diminish the conditioning and fan energy associated with outside air supply, occupancy sensors and carbon dioxide monitoring should be used to determine the quantities required (CO_2 serves as a proxy for occupancy). Decoupled cooling and ventilation systems such as chilled beams should be considered for spaces with high sensible loads.

Natural ventilation should also be investigated for the non-lab buildings. By using unconditioned outside air when conditions are favorable, energy use associated with heating and cooling air can be minimized. As part of the natural ventilation design, operable windows with contact sensors may be used in perimeter office and conference spaces. When the windows are opened, a signal to the building automation system will close down the air terminals to those spaces.

Water-side Energy Savings. As noted above, the distribution of cooling energy via water rather than air is typically much more efficient. Zone level cooling also creates energy efficiency opportunities due to elevated chilled water temperatures. This warmer chilled water can be provided via the return leg of the campus chilled water system, via water-side economizing with a fluid cooler device, or via chillers in the building operating at higher efficiency due to decreased lift.

Exhibit 78: Office Space Energy Strategy



Solar Energy Systems. NIST has a strong history of supporting solar technologies, especially photovoltaic energy systems. Building designs should consider inclusion of the renewable energy PV systems both on top of the building structure and over the canopy shielding the parking areas. The quantity, orientation and efficiency of the PV cells should be as required to achieve the net zero energy criteria. The maximum roof coverage should conform to the fire marshal mandates and local ordinances. In addition to building roof and parking structures, approximately 1.2 acres of site will be available when Building 25 is demolished. If this entire site is allocated for a PV field, about 570 kW of generation with 970 MWh/year of electrical energy savings may be realized. This is based on the current higher end panel efficiency of 21% which is anticipated to be more of an average panel efficiency when the system is likely to be implemented.

Geothermal Systems: Buildings with relatively balanced cooling and heating load profiles such as the child care center and administration building should consider geothermal HVAC system. Economic feasibility of such system should be evaluated during design with consideration to soil conditions and local environmental regulations.

7 Circulation Framework

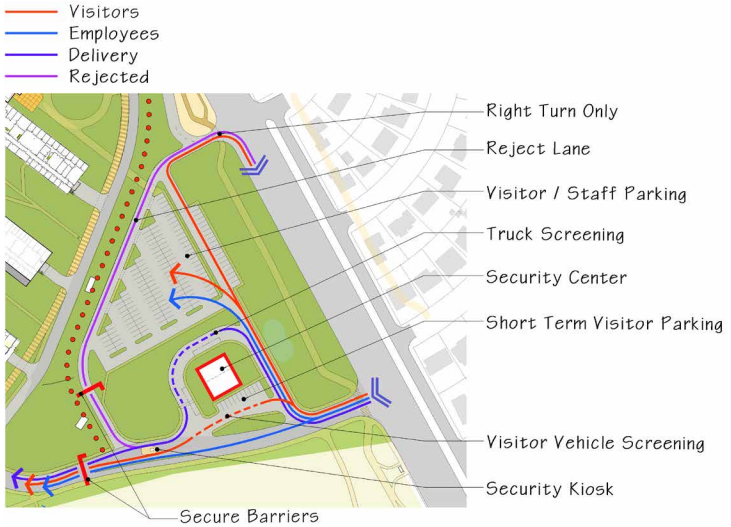
7.1 Circulation and Parking

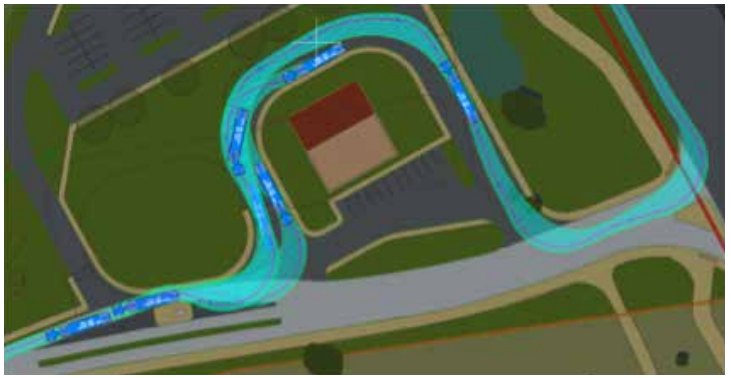
The Master Plan proposes incremental changes to the campus, in conjunction with the proposed new construction and renovation of the facilities. Most of the proposed changes are independent of one another. The following is a summary of the key changes to the circulation system corresponding to the construction and renovation proposals in the Master Plan:

- The central roadway between Buildings 3 and 81 would be eliminated with the construction of the new research buildings.
- Its extension, Curie Circle, would be reconfigured with the relocation and construction of the Childcare Center.
- The reconfiguration of the roadways and screening areas surrounding the Security Center should be timed with the Visitor Pavilion and expanded Security Center, although the parking lot changes could precede this.
- Compton Road, the north-south roadway dividing the central campus green, ideally would be limited to bicycle, pedestrian, and emergency traffic. It would preserve the central part of the campus as a more pedestrian and bicycle oriented space. However, this would cause some additional circulation for vehicles accessing the new parking garage behind Building 81.

As the Master Plan is implemented, the DoC may wish to develop a Transportation Management Plan that seeks to further reduce the number of single occupancy vehicles arriving on campus. DoC has already managed demand by encouraging and supporting bicycle commuting and providing transit subsidies.

Exhibit 79: Circulation Improvements for the Campus





Truck circulation/screening diagram

Exhibit 80: Circulation

Exhibit 81: Road Network and Service Delivery improvements

Visitor and Delivery Screening

Visitor screening is planned to continue at the reconfigured Security Center, Building 51. Visitors are expected to proceed into the Security Center building, park in front of the building and complete the verification and screening inside the building. The vehicle screening process will be accomplished curb side before proceeding to the entry gate into campus.

Fewer parking spaces are planned directly at the Security Center than exist in the current configuration, but the reconfigured parking lot to the north will be connected to the external campus roadway network, allowing visitors to park their vehicles outside of the security perimeter and to walk into the campus. This will remove vehicular pressure from the security gate, allowing it to primarily serve employees, delivery truck drivers, and others that have need to use a vehicle on campus. Visitors for conferences and other large meetings will be able to park in the lot north of the Security Center, reducing additional queuing at the security booth during large conferences and meetings.

Truck and delivery screening is planned to continue to take place at the reconfigured Security Center. Additional space is planned on the east, north, and west for parking and screening for up to three 55-foot trucks. It is expected that, as with visitors in personal vehicles, truck drivers will proceed into the Security Center building for personal screening and verification and will then have their truck screened at curbside before proceeding to the entry gate into campus. The driveway around the Security Center will be expanded and reconfigured for truck maneuvering and parking. The truck lane through the security booth and gate should be 14-16 feet in width to allow for maneuverability. It is recommended that the turning area east of the security booth and gate should be striped rather than curbed for truck maneuverability. To that end, turning maneuvers should be examined with AutoTurn (or a comparable program) as design plans are developed to determine the adequate curb alignment for trucks to continue to the gate area.

Any rejected vehicle, whether car or truck, would exit the site along the new parking lot drive, to the existing Medical Center drive at Broadway. Gate controls are planned, which will be developed and finalized at design. Exiting vehicles will be physically restricted to a right turn only at Broadway.

Exhibit 82: Relocated Building 1 Maneuvers

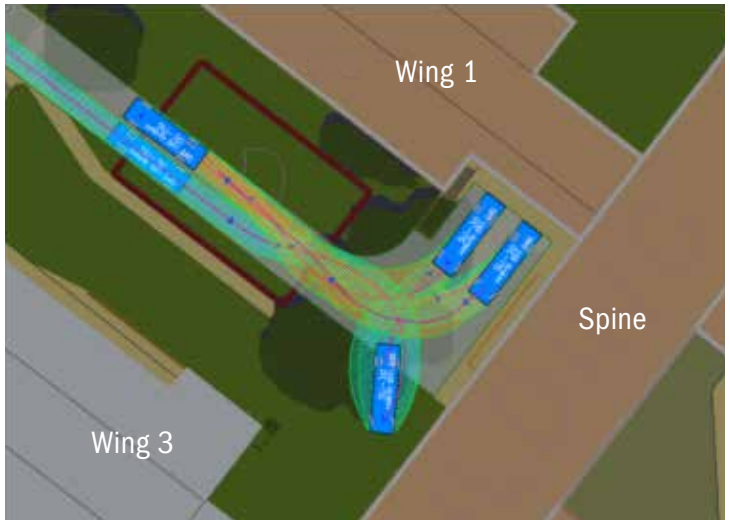


Exhibit 83: New Research Building Loading Dock Truck Maneuvers

These diagrams illustrate where new paving would be required for maneuvering.

7.2 Loading Docks and Service Areas

New loading docks are proposed at the research buildings. Relocation of the primary loading dock for Building 1 has also been proposed to the north side of the building. Loading and service for the Management Resources Center will be an important consideration during the building design. The loading areas should be designed to ensure adequate maneuvering area for trucks to back into loading docks and evaluated on the specific needs of the loading facility (i.e. size of trucks expected) and surrounding constraints. It is recommended that AutoTurn (or a similar program) be used during design of loading facilities to test turning maneuverability.

External delivery trucks are expected to continue to use Building 22 for deliveries, as is current practice. Deliveries are taken at Building 22 and then distributed throughout the campus to the various end destinations. Today, large trucks sometimes intrude into the adjacent roadway for backing maneuvers into the Building 22 loading docks. The Master Plan recommends a widening of the road at Building 22, to improve maneuvering and ensuring that the truck is out of the travel lanes of the adjacent roadway once it is parked.

7.3 Parking

When evaluating parking needs for a large campus, parking occupancy is often evaluated on a per-lot or a per-quadrant basis. It is unlikely that the parking lot layouts proposed in the Master Plan will be followed exactly during implementation. Accordingly, it is reasonable to determine the parking needs for each portion of campus based on demand associated with the uses within the proximate buildings.

Parking usage data was collected and documented for each lot. The campus currently has 1,430 spaces for 1,761 employees. On an average day, 71% of the parking spaces were occupied indicating 0.58 occupied parking spaces per employee for the campus, overall.

For the Master Plan, the parking needs were evaluated based on the redistributed uses. A total of 1,525 spaces have been proposed in the Master Plan. In general, the proposed parking provisions reflect a higher space per employee ratio than the existing occupied spaces per employee. Applying current demand ratios to the Master Plan development, the average day peak parking demand for the campus is expected to be about 1,127 vehicles. Some sharing of parking between Quadrants 1 and 2 is likely.

Parking facilities are generally considered to be "full" when they reach 90% occupancy. Accordingly, a parking supply of 1,252 parking spaces would be needed to accommodate the average day demands of the campus and any minor fluctuations. A maximum occupancy of 75% is sometimes targeted for additional flexibility, which would require 1,503 spaces in the campus when the Master Plan is fully implemented.

Large conferences can skew the average day demand significantly. The Institute of Transportation Engineers (ITE) manual suggests that conference centers may expect parking ratios of approximately 0.31 vehicles per conference attendee. Based on an optimum conference attendance of 500 people (the highest recorded conference attendance is 537), an additional parking demand of 155 vehicles could be expected. However, such conferences would also include a number of DOC employees amongst its attendees. The parking spaces provided in the Master Plan should be sufficient to accommodate the campus peak demand even when large conferences are hosted.

A visitor parking lot has been provided near the campus entrance to allow visitors who can park without undergoing a vehicle screening process. It will provide added flexibility in accommodating visitor parking during special events such as large conferences and ease vehicle screening loads at the security center. DoC staff will share this parking space with visitors at other times. In order to accommodate conference attendees, DOC may want to require employees to avoid parking in the visitor parking lot when large conferences are hosted in the campus.

Parking on the GSA-managed lot near the David Skaggs Research Center B33 has a capacity of approximately 600 cars. The projected program does not require any capacity change to this lot, however the Master Plan recommends modifications to increase permeability and reduce the visual impact of this "sea of parking." Suggestions include decking a portion to allow the removal of some surface paving, taking advantage of the site's upward slope. Introduction of trees and other plantings would assist in the mitigation.

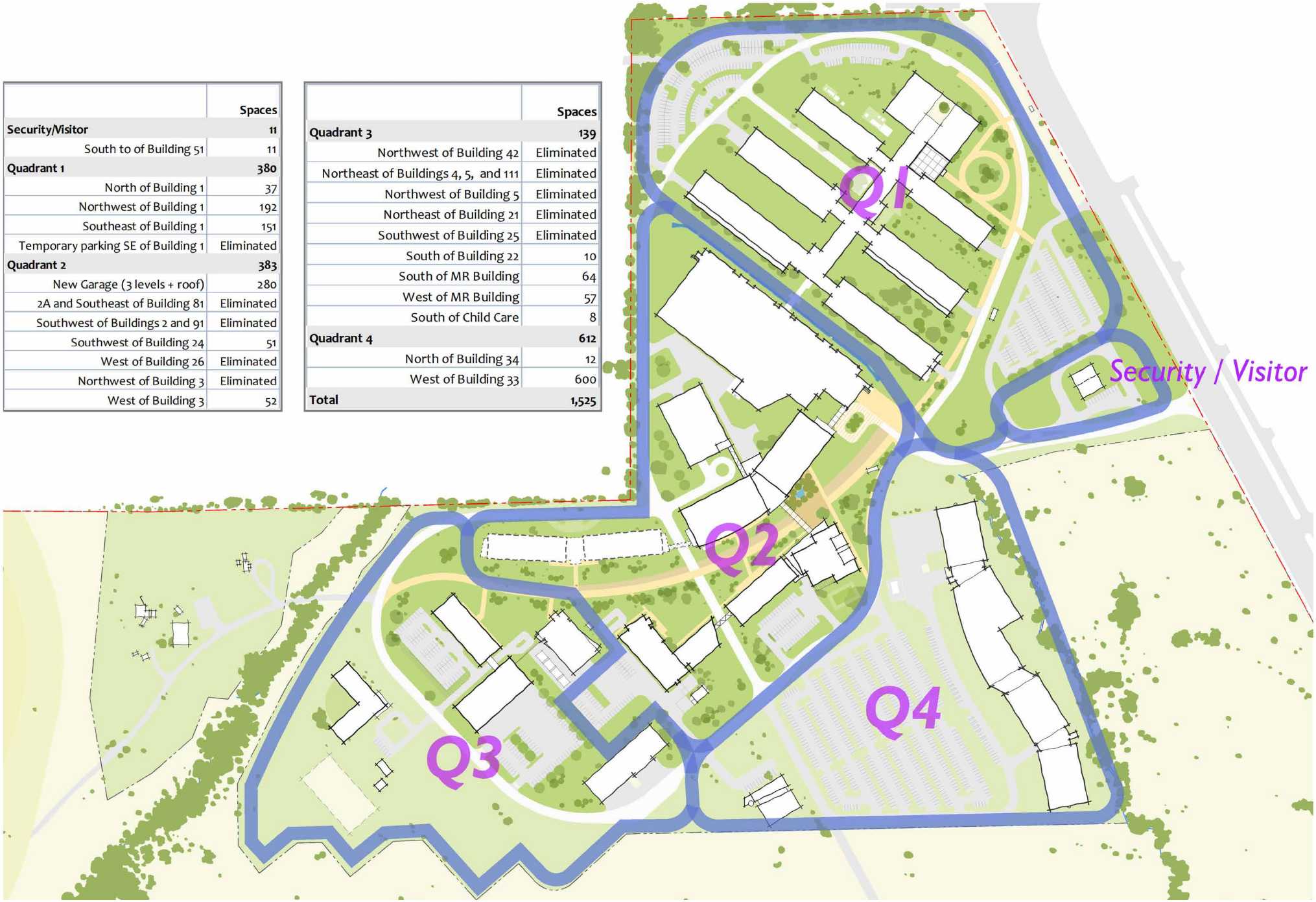
Exhibit 84: Future Parking Provisions

Scenario	Quadrant 1		Quadrant 2		Quadrant 3		Quadrant 4		Security/Visitor		Total	
Existing												
Employees	414	employees	327	employees	86	employees	933	employees	1	employees	1,761	employees
Parking Spaces	444	spaces	222	spaces	134	spaces	605	spaces	25	spaces	1,430	spaces
Occupied Spaces	222	vehicles	220	vehicles	88	vehicles	480	vehicles	9	vehicles	1,019	vehicles
Occupied Spaces/Employee	0.54	spaces/ employee	0.67	spaces/ employee	0.56	spaces/ employee	0.51	spaces/ employee	9.00	spaces/ employee	0.58	spaces/ employee
Campus Master Plan												
Employees	400	employees	388	employees	173	employees	1,008	employees	4	employees	1,973	employees
Proposed Supply	380	spaces	383	spaces	139	spaces	612	spaces	11	spaces	1,525	spaces
Proposed Ratio	0.95	spaces/ employee	0.96	spaces/ employee	0.80	spaces/ employee	0.61	spaces/ employee	2.75	spaces/ employee	0.77	spaces/ employee
Avg. Day Demand	214	spaces	261	spaces	97	spaces	519	spaces	36	spaces	1,127	spaces
Demand Ratio	0.54	spaces/ employee	0.67	spaces/ employee	0.56	spaces/ employee	0.51	spaces/ employee	9.00	spaces/ employee	0.58	spaces/ employee
10% Space Recommended Supply	238	spaces	290	spaces	108	spaces	576	spaces	40	spaces	1,252	spaces
10% Supply Ratio	0.60	spaces/ employee	0.75	spaces/ employee	0.62	spaces/ employee	0.57	spaces/ employee	10.00	spaces/ employee	0.63	spaces/ employee
25% Space Recommended Supply	286	spaces	348	spaces	129	spaces	691	spaces	48	spaces	1,503	spaces
25% Supply Ratio	0.71	spaces/ employee	0.90	spaces/ employee	0.75	spaces/ employee	0.69	spaces/ employee	12.00	spaces/ employee	0.76	spaces/ employee

Exhibit 85: MP Parking

	Spaces
Security/Visitor	**11**
South to of Building 51	11
Quadrant 1	**380**
North of Building 1	37
Northwest of Building 1	192
Southeast of Building 1	151
Temporary parking SE of Building 1	Eliminated
Quadrant 2	**383**
New Garage (3 levels + roof)	280
2A and Southeast of Building 81	Eliminated
Southwest of Buildings 2 and 91	Eliminated
Southwest of Building 24	51
West of Building 26	Eliminated
Northwest of Building 3	Eliminated
West of Building 3	52

	Spaces
Quadrant 3	**139**
Northwest of Building 42	Eliminated
Northeast of Buildings 4, 5, and 111	Eliminated
Northwest of Building 5	Eliminated
Northeast of Building 21	Eliminated
Southwest of Building 25	Eliminated
South of Building 22	10
South of MR Building	64
West of MR Building	57
South of Child Care	8
Quadrant 4	**612**
North of Building 34	12
West of Building 33	600
Total	**1,525**



8 Sustainable Design Approach

THE Master Plan incorporates sustainable design and energy efficacy as core principles and one of its goals. The campus development approach incorporates environmentally-responsible strategies into the plan and the building design guidelines. Certain principles are inherent in the Master Plan as it is implemented, and certain principles are enabled with the design of specific buildings following the Design Guidelines. The following are key sustainable design approaches:

- **NIST Requirements**: Meet the requirements of the NIST *Sustainable Design Manual*, July 31, 2014, and the DoC *Real Property Management Manual*, August 2014, rev. March 2017, and any subsequent revisions. The Manual reflects both NIST and DoC policies on sustainable design and the Federal Executive Orders and mandates on which they are based. Compliance with the CEQ's *Guiding Principles for Sustainable Federal Buildings and Associated Instructions*, February 2016, is required.
- **Energy Efficiency**: Improve the energy efficiency of the campus facilities, meeting Department of Commerce goals. Implementation of the Master Plan will increase energy efficiency through the elimination of aging and inefficient mechanical systems that serve the 15 buildings that will be replaced. In addition, consolidation of scattered administration and support functions into one shared building will provide better service, reduce duplication and incorporate modern energy efficient systems. The major proposed buildings would be connected to services from the Central Utility Plant (CUP). Locations for solar panel arrays are identified, both building-related and at-grade locations.

  Energy efficient design strategies are recommended for the planned buildings, supported by the Design Guidelines. Recommended strategies for all the new and renovated buildings include: clustered building functions to allow the most efficient HVAC system design and distribution; daylighting; high performance building envelopes; natural ventilation, energy efficient equipment and systems. Energy conservation approaches should consider demand controls, process energy recovery, fume hood controls, de-coupled cooling and ventilation, air-side and water-side economizers. Site-wide projects should incorporate energy conserving and solar technologies that will continue to evolve over the life of the Master Plan. Both the Management Resources building and the Childcare Center are proposed as net-zero buildings, targeting reduced energy demand and efficient systems augmented by solar energy, although inclusion of the data center may prevent full realization of this goal. The general approach first reduces the demand for energy through building design and organization, followed by the selection and commissioning of energy efficient systems, and then the provision of clean renewable energy.
- **Water efficiency**: Keep water use within the levels allowed by State permit, even with the projected new buildings and lab modernization. The NIST goal is a 20% reduction in potable water use over the baseline for each building. The high water use on campus must be reduced, by investigation of possible leakages, control of use in labs for cooling, and installation of water efficient systems. Water conservation in Colorado is especially important because water reuse and rainwater collection are not permitted.
- **Stormwater Management**: Utilize strategies to ensure stormwater quantity and quality control, including landscape "best management strategies" such as swales and plantings that increase ground water recharge rather than runoff. The parking demand has only a minimal increase with the Master Plan, and a recommended parking garage

will reduce the impermeable surface on campus, as will the removal of the central drive.

- **Daylighting**: Organize the buildings to maximize the use of natural light for illumination and occupant comfort, specifically to the staff offices, support and corridors. Daylighting within the laboratories is not typical because of research requirements, but this should be discussed with each building project. The NIST Sustainable Design Manual sets a minimum goal of a 2% daylighting factor for 75% of regularly occupied areas.
- **Adaptive Reuse**: Utilize existing buildings that are in good condition, and renovate them for compatible uses. Building 1 is undergoing an extensive phased renovation to provide advanced research facilities in the 1952 shell. Building 24 is no longer appropriate for advanced research, but can be easily renovated for employee services and amenities. A number of other buildings are recommended for removal by the Master Plan because they are not in good condition, not adaptable to current needs or were installed as modular/temporary buildings.
- **Heat Gain and Wind Moderation**: Moderate the solar heat gain on the buildings through glazing selection and orientation, envelope and roof design and screening with vegetation. The prevailing wind primarily comes from the south. The new campus green and pedestrian path would be sheltered by the new buildings and added trees.
- **Landscape Stewardship**: Minimize the disturbance of landscape features when new buildings and infrastructure are constructed. The Master Plan concentrates new development on sites that have already held buildings and paved areas, with the exception of the Childcare Center. Buildings would be located on relatively flat land, following the contours to minimize cut and fill. The protected area would not be altered by Master Plan recommendations, but remain as native vegetation with pedestrian trails.
- **Appropriate Planting**: Augment the tree cover to moderate temperatures, shade the buildings, enhance stormwater management and absorb pollutants. The new campus green balances the use of lawn for activity areas with native or adapted species for easy maintenance and to reduce fertilizer and pesticide use. Minimize water-dependent landscapes and water intensive plantings that require irrigation.
- **Renewable Energy**: Utilize renewable energy technology for both electricity and hot water. Solar technology is recommended for installation on the Management Resource building, the new Childcare Center, over the new garage and potentially on other buildings. Additionally, a site location for a solar panel field has been identified southwest of the Warehouse Building 22. The NIST *Sustainable Design Manual* sets a goal that 30% of hot water needs be met by solar technology. A feasibility and economic analysis should be conducted in light of this Master Plan and the solar research findings from the Gaithersburg campus.

8.1 Current Sustainable Design Policies

The Master Plan promotes an integrated view of sustainability, incorporating Federal policies, guidelines and directives and going beyond minimum standards toward creative environmental strategies.

The Master Plan integrates sustainability policies outlined by the Department of Commerce and NIST, referencing other Federal sustainability regulations. Included are: the NIST *Sustainable Design Manual* of July 31, 2014; the DoC *High Performance and Sustainable Building Handbook* of February 15, 2011, the DoC *Environmental Management System Operations and Implementation Manual* of October 2013, and the DoC *Implementation Handbook for the Strategic Sustainable Building Plan* of June 2013. Federal regulations include the Energy Policy Act of 2005 (EPAct 2005), Executive order 13423 (EO 13423), Energy Independence and Security Act of 2007 (EISA 2007), EO 13693 and EO 13693. These current regulations may change in the future, and each project would be designed to meet the sustainability regulations in place at that time.

The DoC *High Performance and Sustainable Building Handbook* and the NIST *Sustainable Design Manual* provide the framework for the Department's overall sustainability program, summarizing the Department's program for incorporating sustainable measures into its building assets. These and the supplementary documents reflect the requirements of Executive Order (EO) 13514: Federal Leadership in Environmental, Energy and Economic Performance and the Guiding Principles[2] it espouses.

Recently, EO 13514 has been revoked and superseded by Executive Order 13693: Planning for Federal Sustainability in the Next Decade, signed March 25, 2015. The Master Plan

2 Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding Guiding Principles; Interagency Sustainability Working Group; 2006

Exhibit 86: Sustainable Design Features

anticipates that the DoC and NIST will update their sustainability policies and document to conform to the new requirements.

Key provisions of EO 13693 include the following:

- *Guiding Principles*. The 2006 *Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding Guiding Principles* are included in the earlier EO 13514, and are referenced in 13693 with the instruction to update them within 90 days. The *Guiding Principles* contain specific requirements in the following areas:

  I. Incorporate Integrated Design Principles
  II. Optimize Energy Performance
  III. Protect and Conserve Water
  IV. Enhance Indoor Environmental Quality
  V. Reduce Environmental Impact of Materials

- *Energy and Water Conservation*. Each agency is required to meet energy reduction, clean energy and water use targets over the next ten years. Among them is a target of 30% renewable energy by FY25 and a requirement to reduce energy intensity by 2 ½% a year from FY 15 to FY 25.

- *Zero-net Energy*. New federal buildings greater than 5000 GSF in size, for which planning is initiated in FY20 or later shall be designed to achieve zero-net energy by FY30, with interim targets each 5 years. A zero-net energy building is defined as "a building that is designed, constructed and operated such that actual annual source energy consumption is balanced by on-site renewable energy.[3]

Building Rating Systems

NIST's Sustainable Design Manual requires certification by a third-party for all major construction or renovation projects, as well as meeting the Design Manual requirements and those of the *Guiding Principles* checklist. Certification by either Leadership in Energy and Environmental Design (LEED) (Silver level) or Green Globes (two globes) is acceptable. LEED, developed by the United States Green Building Council, and Green Globes, developed by the Green Building Initiative, are both programs to assess building performance and meet broad sustainability goals. They differ in their assessment procedures and emphasis on specific areas of sustainability. Both programs are updated regularly, and current standards should be reviewed with each construction or renovation project.

Labs21 is a separate standards program that addresses laboratory buildings. Labs for the 21st Century (Labs21) was created as a partnership between the US Environmental Protection Agency, the US Department of Energy, and the International Institute for Sustainable Laboratories, and seeks to improve energy efficiency and environmental performance of the nation's labs on a voluntary basis (Labs21, 2008). This program bridges the gap in current implementation strategies (i.e., Green Globes, LEED) for sustainable design associated with laboratories. The Master Plan recommends that Labs21 be used as a means to design and evaluate the performance of sustainable laboratory facilities.

3 Executive Order 13693: Planning for Federal Sustainability in the Next Decade; March 25, 2015

Exhibit 87: Impervious and Pervious Area, Existing

	Research Zone 1 SF	Research Zone 2 SF	Research Zone 3 SF	Protected Area SF	Total SF	Total Acres
Impervious Areas	34,600	31,800	**2,001,600**	174,700	**2,242,700**	**51**
Buildings	1,100	5,400	608,400		614,900	14
Antenna Field			20,100		20,100	0
Other Structures/Areas		2,500	84,000	1,700	88,200	2
Utility Yard			70,500		70,500	2
Parking/Loading Areas	1,800	5,000	725,900		732,700	17
Road/Side Walk	31,700	18,900	492,700	173,000	716,300	16
Pervious Areas	476,800	277,900	**1,627,400**	4,333,800	**6,715,900**	**154**
Total Site Area	511,400	309,700	3,629,000	4,508,500	8,958,600	206

Exhibit 88: Impervious and Pervious Area, Master Plan

	Research Zone 1 SF	Research Zone 2 SF	Research Zone 3 SF	Protected Area SF	Total SF	Total Acres
Impervious Areas	34,600	31,800	**1,894,100**	174,700	**2,135,200**	**49**
Buildings	1,100	5,400	686,600		693,100	16
Antenna Field			20,100		20,100	0
Other Structures/Areas		2,500	12,600	1,700	16,800	0
Utility Yard			4,100		4,100	0
Parking/Loading Areas	1,800	5,000	627,000		633,800	15
Road/Side Walk	31,700	18,900	543,700	173,000	767,300	18
Pervious Areas	476,800	277,900	**1,734,900**	4,333,800	**6,823,400**	**157**
Total Site Area	511,400	309,700	3,629,000	4,508,500	8,958,600	206

9 Implementation Planning

THE Master Plan is a look into the future and a plan to build and renovate facilities in order to meet current and anticipated needs. Twenty years is the timeframe for this Master Plan, and the changes have been prioritized and shown as a continuum of construction, rather than structured phases 1, 2, 3. This approach reflects the needs on the Department of Commerce campus, which are not based on gradual growth over 20 years, but on current needs—research requirements, aging facilities and inefficient operations.

As with any institution, DoC's program of renovation and construction are dependent on many factors—e.g. funding, research and agency-wide priorities. The Master Plan, therefore, becomes a living document, setting a framework that remains flexible and sensitive to the timing and composition of specific projects. The phasing of the plan is organized to meet the following implementation goals:

- The Master Plan is driven by physical and functional needs, with growth integrated as a modest contributor
- The Plan phases research facility renovations and replacement as a steady process, designed to gradually improve infrastructure and research environments, while minimizing disruptions to research programs.
- The Plan allows great flexibility in the phasing of non-research facilities, because their implementation is independent of the research facility changes. These replacements should proceed when priorities and funding dictate.
- The Plan is able to accept variations in timing and project groupings
- The Master Plan appears "complete" at the end of each phase or significant addition.

The purpose of the Master Plan is to guide future development; it does not represent the pre-approval of any individual facilities project or the specific needs of programs to be accommodated on the campus. The financing of such projects and programs must be addressed within the annual DoC budget process and review mechanisms. Furthermore, the Master Plan is not a commitment for the agency to build these facilities within a specific timeframe. Sometimes a twenty-year Master Plan becomes a thirty-year plan or a fifteen-year plan, yet the framework for this development remains valid.

9.1 Phasing Priorities

Phasing of the campus projects is very flexible, because each of these packages could be implemented independently of the others, and in any order that responds to DoC mission, policy and funding. The Master Plan components are all needed today, to satisfy functional and physical facility need. They are not changes based on incremental growth.

Building 24—Existing

Courtesy NIST

Exhibit 89: Phasing Packages

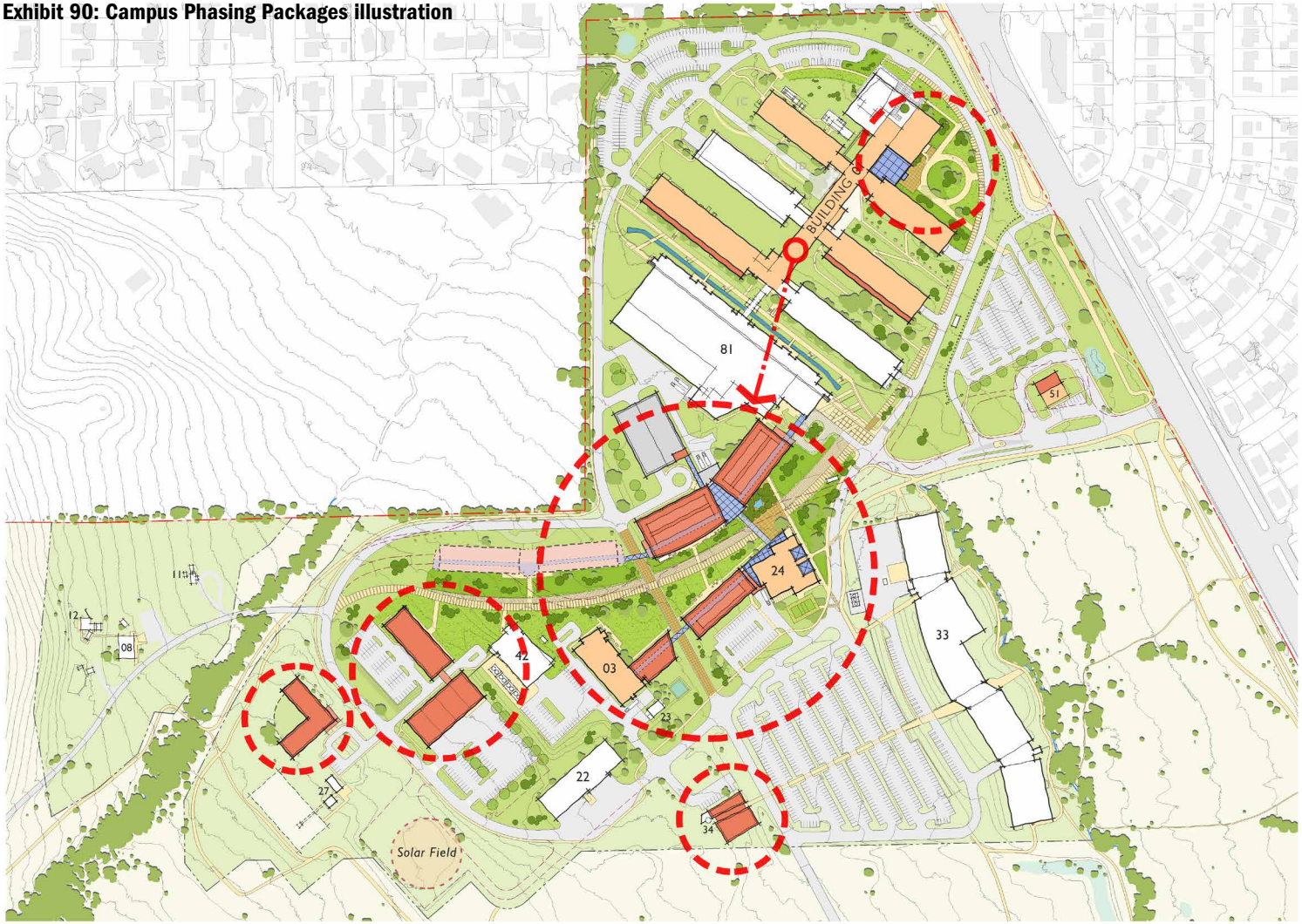
Phasing Packages	Major Components	Comments
NIST Research Buildings	Building 1 Renovations Building 3 Repurposing	Multi-step process to ensure research continuity
	New Research Buildings, replacing Building 2, 2A & 24 labs Demolition of Buildings 2, 2A Creation of Campus Green, center section Road/parking modifications; partial removal of center road New Parking Garage	
Campus Center	Renovation of Building 24 Covered connection to new research buildings Pedestrian, parking modifications	Follows or is combined with New Research Buildings
Visitor Center, Parking and Vehicle Screening	New visitor pavilion at Building 1 Conference center renovation; loading dock relocation Parking lot modification Roadway and vehicle screening modifications Addition to Building 51	Independent package; could proceed at any time. May be advantage to combine B1 visitor pavilion with other B1 construction.
Management Resources Center	New Management Resources Center Swing space for Building 4, 5 occupants Demolition/removal of 10 support buildings Roadway, parking, utility yard modifications Installation of solar collection field	Independent package; could proceed at any time. Completion would free up some space in B1
NOAA Research Building	New research building or expansion of Building 34 Roadway, parking modifications Road/truck maneuvering expansion at Building 22	Independent package; could proceed at any time.
Childcare Center	New Childcare Center, replacing existing Building 26 Landscaped play areas Removal of remainder of center road & relocation of Curie Circle Completion of Campus Green	Independent package; could proceed at any time. Must be completed if/when future lab buildings are desired.

Research facility improvements have been the primary goal of the Master Plan Steering Committee, an outlook supported by the currently planned renovation/expansion projects in Buildings 1 and 3. The Master Plan anticipates that continuing those renovations and then replacing Building 2 will be the first implementation priority. Creating the campus green along with new research buildings will improve the cohesion and visual image of the campus.

Management Resources Center's replacement of 10 small inefficient buildings with a modern, well designed building is another significant project. Its implementation will save NIST money for many years through energy savings, maintenance needs and operational efficiency.

Although a smaller project, the Visitor Center, Parking and Vehicle Screening improvements will address security issues and support the operations of the DoC Boulder Laboratories organization and the NOAA programs. The Campus Center is another shared function that will enhance the operations of the research community. Planned as a renovation of the lab Building 24, the Campus Center is anticipated to follow the construction of the new research buildings, unless alternate housing can be found for the research functions. Temporary parking may be necessary during certain phases, prior to the construction of the garage.

Exhibit 90: Campus Phasing Packages illustration



9.2 NIST Research Building Phasing Package

Components:

- Building 1 laboratory renovations, Wings 4, 5 and the Spine. Renovation of Wings 1 and 2 will follow.
- Building 3 repurposing and expansion
- New research buildings
- Creation of the Campus Green, center section
- Road, parking modifications and partial removal of the center road
- New parking garage
- Campus Center

Implementation Steps

1. Planned Renovations. First, implement planned changes to Building 3, to accommodate CTL Laboratory functions. This project is underway through a design-build contract. Implement planned renovations to Wings 5 and 4 and the Spine in Building 1. This modernization and renovation is the next phase of the planned Building 1 renovation program, and currently is funded through the design phase. NIST is planning to reserve swing space in Building 1 as space is reassigned after Wings 4, 5 renovation. Renovation of Wings 1 and 2 will follow.
2. Partial Demolition of Building 2: Relocate personnel and research project from Buildings 2A and 2 to planned swing space in Building 1, and demolish the 1951, 1986 and 1995 sections of Building 2. The section built in1964 will remain operational and occupied. This demolition will require modified and/or temporary building systems, and re-routing of the services coming from the utility tunnel.
3. Construction of New Laboratory Buildings. The replacement laboratories are shown as two buildings and an addition to the CTL labs in the now-renovated Building 3. These multiple buildings are anticipated to be one construction project. However, the building by existing Building 2 should proceed first if all cannot be funded at one time.
4. Creation of Campus Green. After construction of the laboratories, the center road from the Building 81 to Compton Road will be removed, and the intersection modified at Building 81. Compton Road will remain. The pedestrian walkway, the plaza by Building 81 and terraces/sidewalks by the new buildings will be implemented. The plantings and the stormwater swale will be constructed in this area.
5. Campus Center Renovation. Building 24, slated to become the Campus Center, houses laboratories that will be replaced by the new research buildings. Thus the Campus Center will be implemented after the new construction, and parallel with the creation of the Green. This could be expedited if replacement laboratory space were identified earlier.
6. Parking. The parking structure will be constructed to the north of the new research building, after occupancy and after the demolition of the remaining part of Building 2.

Exhibit 91: NIST Research Building Phasing Package

Note: Black and white base plan shows existing campus layout.

Disruption

- Continuity of research programs is required.
- For the renovations, B3 can be isolated from most pedestrian circulation. Staging area around B3 will need to be created, and the space between B3 and B42 will need to be kept clear for services and deliveries. Wing renovations within B1 will have only minor disruption in the building, but contractor parking will impact employee parking around the building. Renovation of the Spine must be done in stages to control disruption to building circulation and services.
- The center road will be kept open during building construction.
- Temporary access and protections will be required for the staff working in the remaining B2 wing during construction of the new research buildings. Temporary parking will be needed if construction on the B24 lot precedes the construction of the garage.

9.3 Visitor Center, Parking and Vehicle Screening

Components:

- New Visitor Pavilion at Building 1
- Conference center renovation
- Relocation of the loading dock at Wing 2
- Parking lot modification
- Roadway and vehicle screening modifications
- Creation of entry plaza

Exhibit 92: Visitor Center, Parking and Vehicle Screening Phase

Note: Black and white base plan shows existing campus layout.

- New sidewalk connections for visitors and bus riders
- Addition to the Security Center, Building 51

Implementation Steps

1. Visitor Pavilion. The first step in creating the new visitor pavilion at Building 1 will be the closing and relocation of the loading area and dock that serves Wing 2, adjacent to the main elevator for Building 1. The proposed location is between Wings 1 and 3. Provision must be made for fire department roof access, currently located at the dock. Construction of the pavilion will follow closing of the loading area, including a link into the conference center in the head house of Building 1.

2. Conference center renovations can proceed at the same time as the Visitor Pavilion construction.

3. Parking and Screening. Modifications to the circulation, visitor parking and Security Center addition are not dependent on completion of the new pavilion or any other actions. We suggest that this be done in the same project as the addition to Building 1, and both opened simultaneously to highlight a new visitor/collaboration initiative.

Disruption

- The Visitor Pavilion may block some of the windows in the Spine, depending on the size and configuration of the pavilion.
- Parking will be disrupted when the parking lot and access road is reconfigured, which can be minimized with phased repaving and striping.

Links to other Projects

- Completion of the conference center renovations requires that the swing space in the conference area being used for research personnel be vacated, which may be possible only at the completion of the Building 1 renovations. The final conference center plan can be completed at a later date, if the project schedules do not mesh.
- Relocation of the loading dock to the proposed location between Wings 1 and 3 requires that the temporary Buildings 1C and 1D have been demolished, and the occupants relocated into Building 1. This is planned with the B1 renovations, but could proceed earlier.

9.4 Management Resources Center Phase

Components:

- New Management Resources Center
- Swing space for Building 4 amd 5 occupants
- Demolition/removal of Buildings 3A, 4, 5, 21, 25, 25MI, 91, 111, 112, 131
- Roadway, parking, utility yard modifications

Exhibit 93: Management Resources Center Phase

Note: Black and white base plan shows existing campus layout.

Implementation Steps

1. The location for the Management Resources Center is shown on the footprint of the existing Buildings 4 and 5 because it is the best final location for both pedestrian and vehicular circulation, and completion of the campus green. This means that swing space is needed for the occupants of Buildings 4 and 5. The NIST data base reports 13 people assigned to these buildings at the time of this report. There is one laboratory in B5, but the remainder is office space. Building 4 also contains bulk storage that needs to be relocated (warehouse is suggested).

2. Construction of the Management Resources Center could proceed in two steps, with the administration section constructed first to allow Buildings 3A and 111 to remain occupied, followed by the support section after the office staff from 3A and 111 are moved into the Center. It would be more efficient to construct both sections simultaneously if swing space could be found for the 18 office staff.

3. The 10 support and office buildings will be demolished or removed after the Center is occupied, and the drive, parking and maintenance yard modified.

4. A solar field is proposed on the site that will become available after demolition of Building 25.

Disruption

- Staff in Buildings 3A and 111 will need to be protected if they are not relocated. (Note that both buildings could potentially be moved.)
- The RUPS and temporary structures currently are being removed from the utility yard, which could serves as support and staging for construction.

Links to other Projects

- Curie Circle, the road that loops around existing Building 5, remains in place until the Childcare Center is replaced and relocated. The new access to the CUP Building 42 can be modified with this project, or deferred until Curie Circle is rerouted.

9.5 NOAA Research Building Phase

Components:

- New research building or expansion of Building 34
- Roadway, parking modifications
- Road/truck maneuvering expansion at Building 22

Implementation Steps

1. Building 34 currently is underutilized, and the relocation of some equipment and adjacent Conex containers would allow for the Building 34 expansion or reconstruction into a new facility and the related parking and site modifications.

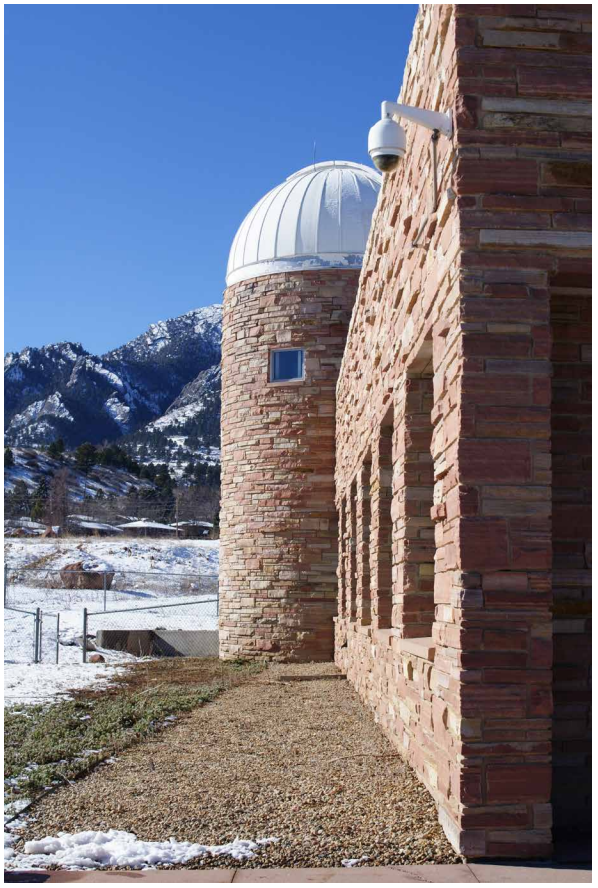
2. Curie Circle, as it passes by this site and the Warehouse Building 22, should be modified during this Research Building Phase, to provide more maneuvering distance for trucks at the Warehouse.

Disruption

- The location shown in the Master Plan would allow the existing satellite dishes to remain in place, if they are protected. The final size and design of the NOAA facility may require that these dishes be moved.

Exhibit 94: NOAA Research Building Phase

Note: Black and white base plan shows existing campus layout.

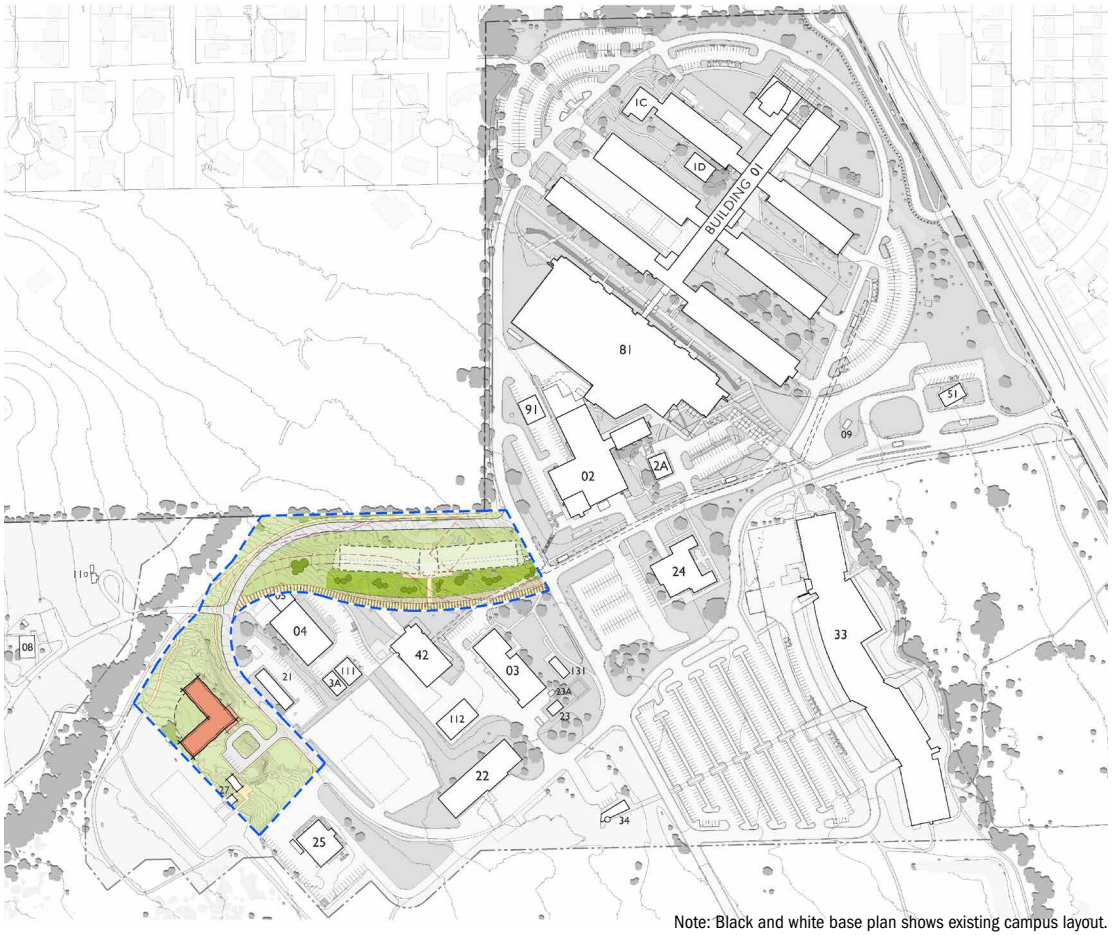


9.6 Childcare Center Building Phase

Components:

- New Childcare Center, replacing existing Building 26
- Landscaped play areas
- Removal of remainder of center road & relocation
- Completion of Campus Green

Exhibit 95: Childcare Center Phase



Note: Black and white base plan shows existing campus layout.

Implementation Steps

1. The existing antenna field is near the proposed site of the Childcare Center, and the final location and building height must be reviewed to avoid any interference with the antenna field operations.
2. Construction of the Childcare Center, play area and adjacent parking.
3. With the removal of the existing Childcare Center building, the western segment of Curie Circle can be relocated, which will complete the campus green, and open up a building site for a possible future research building.

Disruption

- Little disruption of campus activities is anticipated.

10 Design Guidelines

THE Master Plan, as a physical framework for development, was formed around core design and organization principles that address the goals for a future DoC Boulder Laboratories Campus. The Master Plan Steering Committee and administration selected a physical Master Plan concept that created a sense of place, met their functional goals and added flexibility for growth and change. The design guidelines focus on the key characteristics that would maintain those opportunities.

Creating a sense of place and a coherent, functional campus at the Boulder Laboratories requires a consistent design focus and a set of flexible rules. The illustrative plan indicates the preferred Master Plan growth, but recognizes that there needs to be flexibility in its implementation. The design guidelines are the tools that anchor the design principles for a cohesive whole.

These guidelines are intended to provide specificity to ensure the creation of a family of related buildings and open spaces, yet provide flexibility to allow designers creative latitude in responding to aesthetic and programmatic issues. Although many architects and landscape architects resist the constraints of guidelines, these guidelines are intended to highlight the key elements that met Department of Commerce objectives, shaped the Master Plan and led to the selection of the final concept. The guidelines are intended to support creativity, and allow the designers to shape each building and site improvement to meet the program and focus at the time of implementation.

These design guidelines cover several different design elements:

- Open Space
- Architecture
- Landscape
- Circulation and Parking
- Security

These guidelines are specific to the Boulder campus, and are intended to supplement any Department of Commerce standards and polices, as well as requirements and agreements with outside agencies. Specifically, the campus is bound by two agreements with the City of Boulder: a) The *First Amended Irrevocable Easement in Real Property*; and b) *First Amended Memorandum of Agreement*, both finalized on May 8, 1998. The campus has an important research and building history. This should be honored with creative design reflecting the historic context and the Secretary of the Interior Standards, especially for the views, buildings and landscape proximate to Building 1.

10.1 Open Space Guidelines

The campus plan identifies several distinct open space zones, each with different functions and characteristics. Their organization, components and landscape character further distinguish and define the areas.

Campus Green and Campus Walk

The campus green and campus walk serves to visually unify the campus and provide physical organization for new buildings. It will create the "campus feel" within the heart of the DoC complex. Linear in shape, the Green is intended to form the foreground for the existing and new research buildings, and reinforce linkage and collaboration. Landscaping will create areas for outdoor dining, recreation and gatherings. A central pedestrian pathway will connect all the buildings, paralleling the internal circulation within them. This pedestrian path should have distinctive paving, be easy to maintain and designed to support occasional maintenance and emergency vehicles.

Exhibit 96: Public Zone Guideline

Public Zone

Creation of a Public Zone preserves the vehicular security perimeter on campus, while welcoming professional colleagues and interested public to conferences and educational programs. NIST, NOAA and NTIA want to increase the number of these events held on campus by easing the restrictions and time required for visitors to get passes and screen their vehicles. A new entrance pavilion will process visitors into the conference center by screening each person and his or her belongings, as is done in other federal buildings. Separate visitor parking will be located nearby. Key features of the Public Zone include:

- The original front section "headhouse" of the Radio Building 1 will be maintained with its original materials and aesthetic, and in accordance with historic preservation guidelines.
- A visitor pavilion will provide space for security screening, visitor information and informational displays. The pavilion will be a pleasant and clearly recognizable place for visitors to enter the Building 1 conference center, and visible from the visitor parking areas. The pavilion will house magnetometers or other screening equipment that would be spatially difficult to locate in the original lobby space.
- The pavilion and conference center will be separate with its own security that will not permit visitors to enter other areas of Building 1.
- A parking area for visitors will be separate from the internal circulation on campus and available without vehicle screening. Physical barriers, such as large boulders, must prevent cars from driving onto campus roadways from the parking area. Staff will use this parking when there are no conferences planned.
- A driveway and signage at the main entrance will indicate the visitor parking area, and clearly distinguish this activity from the vehicle screening area for those bringing their vehicles on campus.
- Connections to the bus stops and bicycle trails at Broadway should be enhanced, safety improvements at Rayleigh Road and including bicycle parking for visitors.
- Walkways, landscaping and signage must guide visitors and visually define the public zone.

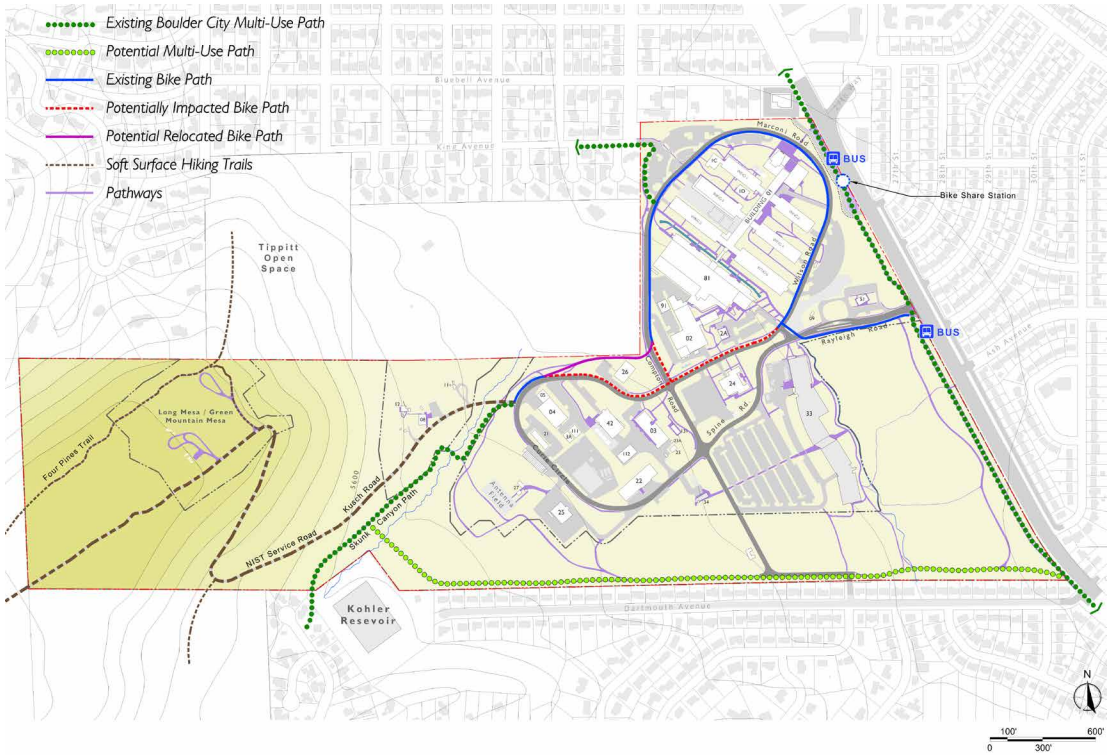
Community Context and Campus Zones

NIST and the Department of Commerce have several agreements with the City of Boulder and a consortium of Native American tribes, which are described in the Background section. The Master Plan follows the guidelines and restrictions of these agreements, and these must be maintained in the design development of any of the proposed facilities unless a new agreement is in place. Key elements are the following:

- Protected Area, a 103.5-acre undeveloped buffer with the surrounding neighborhood
- Public views of Kohler Mesa maintained from Broadway
- Access to bicycle and pedestrian trails in the Protected Area
- Limits on the site buildout square footage, number of parking spaces and building height
- No perimeter fencing around the Protected Area
- Building must follow building codes, and the City has a review and comment period on any development of 10,000 square feet or more.
- See the agreements for more details and other requirements.

In addition to meeting requirements, the DoC wants to be a good neighbor and maintain the natural character of the DoC campus. Consideration examples include screening loading docks and equipment areas, full cut-off luminaires for any exterior lighting, mitigation of any noisy equipment, trip reduction planning, screening of parking areas.

Exhibit 97: Community Trails



View of the Mesa from Entrance at Broadway

10.2 Architectural Guidelines

The architectural guidelines of the Master Plan define the form, bulk, and locations of the principal buildings; the organization of the circulation within the buildings, and the principal design considerations for the building façades. The diagrams indicate principles, not designs.

Building Organization/Geometry

The organizing principle of the plan is a connected, linear arrangement that gently curves up the hill, unifying the independent buildings and defining the central campus green. The linear arrangement recognizes the two underlying grid patterns of existing buildings—anchoring the major new research buildings in the geometry of Buildings 1 and 81, and engaging the grid of the independent buildings as they sweep up the hill. To accomplish this and achieve a demonstrative impact, the Master Plan sets guidelines for the placement of buildings and the alignment of façades.

- The new and existing buildings should be seen to frame the campus green, visible from the central plaza with the green as a foreground. Each building becomes an important part of the campus and the organization and wayfinding is apparent.
- Façades along the south side of the green should align, linking Building 24 to new lab to Building 3. Minimizing the gaps between buildings will better define the green and unify the buildings.
- Façades along the north side of the campus green are anchored by a connection to Building 81, and then gently curve to the north to open up the campus green. Connectivity is maintained.
- The Management Resources Center and the Childcare Center are aligned with the underlying grid pattern of the independent buildings.

Building Organization/Massing

Massing guidelines help to define important spatial relationships between buildings and open spaces. They define building form and the corresponding outdoor spaces of the campus—relating the bulk and placement of new buildings to existing buildings, topography, and the sun.

Simple and flexible building envelopes are preferred, creating buildings that can accommodate different research configurations over time.. For most of the buildings, simple and straightforward clues to the important components of the building—its entrances, ground floor use, and internal circulation—are encouraged. The laboratory massing diagrams generally indicate simple building forms, which is in keeping with the modular nature of laboratory construction. Flat roofs are generally shown, as these will be used for mechanical equipment.

Massing Guideline—Orientation

The Master Plan evolved in order to establish an order to the various buildings on the Boulder Campus. Its gentle curve achieves the objective of bringing order but presents some challenges in controlling the sun as the orientation of the façade changes along the curve. A sun control system that provides deep vertical baffles

Exhibit 51: Existing Site Geometry

Exhibit 98: Central Campus Geometry

Exhibit 52: Master Plan Geometry

on the east then transitioned to shallow vertical but deep horizontal baffles on the south and then back to deep verticals on the west should be considered to address the challenge.

Massing Guideline—Building Heights

Maximum building heights must be in conformance with guidelines established with the City of Boulder and the MOA. Buildings may not exceed 55 feet in height when measured in accordance with Section 84 of the Boulder City Charter, and may not impair the view of the top one-third of Kohler Mesa, as seen by a person standing on Broadway.

Along the northern edge of the campus green, building heights are proposed to be two stories plus an architecturally designed mechanical penthouse. Penthouses on the northern edge of the greenway are encouraged to be integrated with the primary façade of the buildings so that the additional height can help define the perimeter of the greenway. New buildings on the southern edge of the greenway should relate to the height of Building 24 in order to create a consistent edge to the campus green.

Massing Guideline—Floor to Floor Heights

Occupied floors of the buildings should be established at the same elevations as in the adjacent buildings to allow continuous internal circulation and enhance connectivity between building elements and research programs

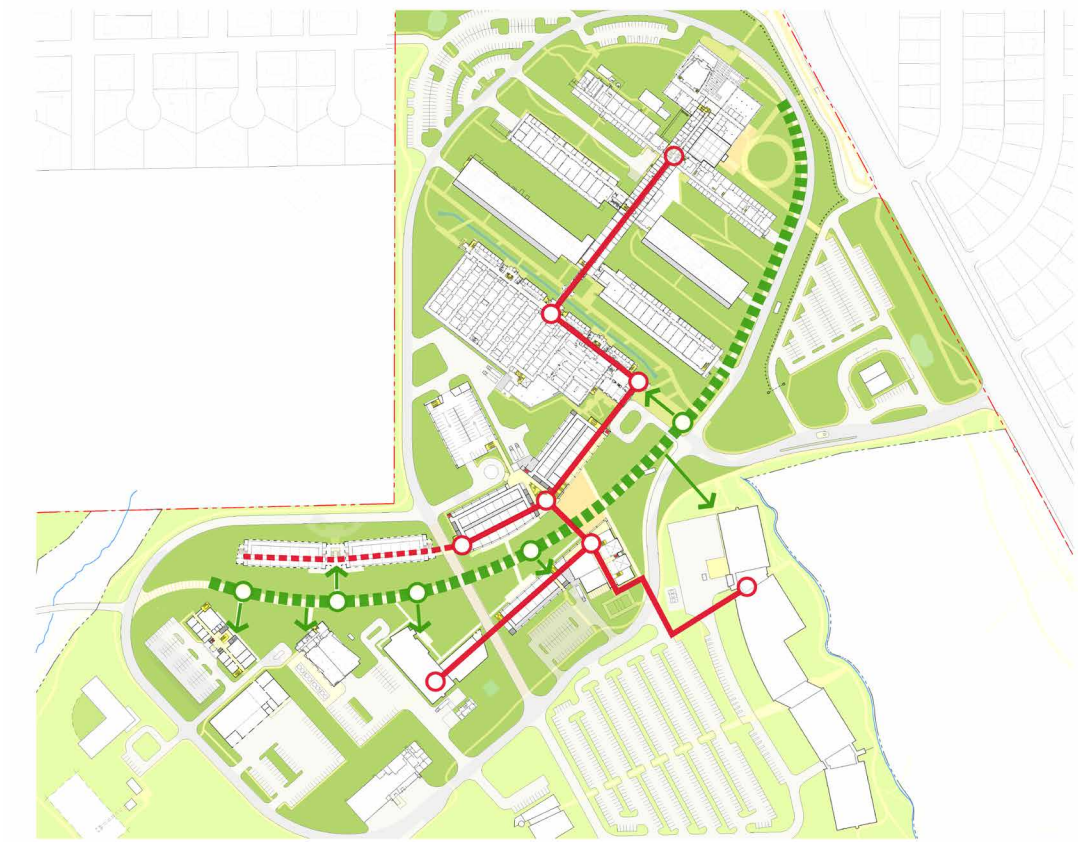
Building Connectivity

The purpose of the building circulation guidelines is to organize movement through the campus buildings in a way that supports efficiency and a sense of orientation, as well as encourages interaction and sharing of resources.

Connection between research buildings is one of the core principles of the Master Plan. The Katharine Blodgett Gebbie Laboratory Building 81 is the gateway to the new laboratory buildings, and the existing connection to the Radio Building 1. New research buildings will be linked by a continuous pedestrian passage from the west side of Building 81. Across the campus green, a research building will be linked to the Campus Center in Building 24, and a covered connection could be extended across the road to Building 3. Key design considerations include the following:

- Covered connections should be provided when enclosed physical links are not practical or desired. One example is the connection across the campus green from the laboratory buildings to the Campus Center. Any covered grade level connections across the wide pedestrian path in the Green (or a road) must have a minimum vertical clearance of 13'6" to allow for the passage of emergency vehicles.
- The campus terrain rises to the west. Connections between research buildings must be maintained even if a level change is necessary.
- Inviting access to the Campus Center in Building 24 should extend to both NOAA and NIST/NTIA facilities. A covered or enclosed connection to NOAA's Building 33 is not envisioned, but a crosswalk and pathway must be provided.
- Connection does not imply sameness. Distinguishing characteristics should assist in orientation and wayfinding as one passes from one building to another.

Exhibit 99: Building Connectivity



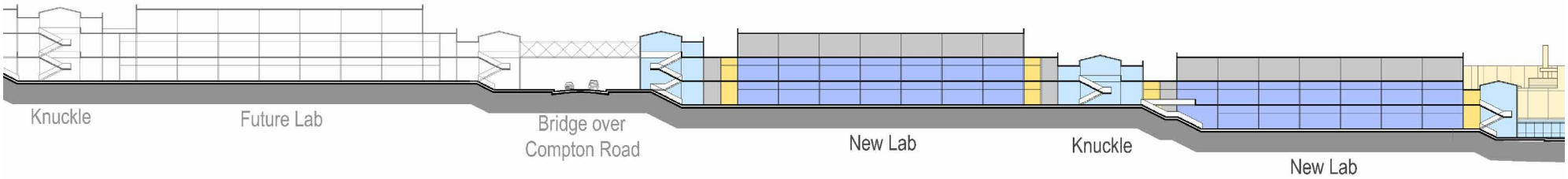


Exhibit 100: Building Connectivity—Section Looking North

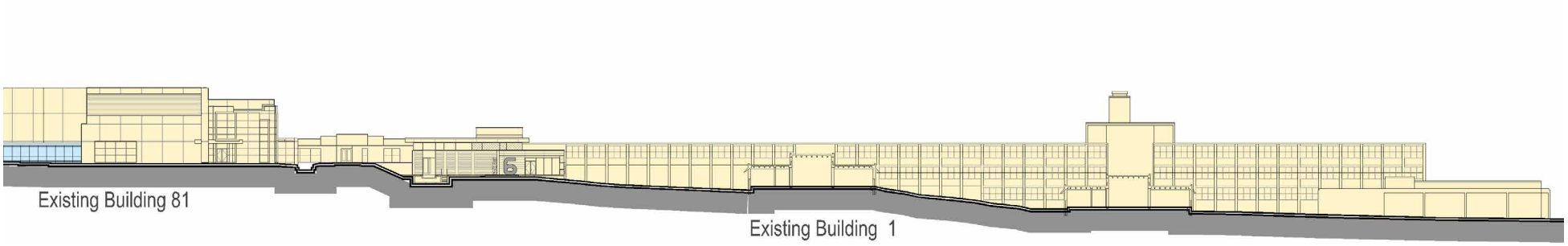
Daylight and Views

The nature and organization of the research buildings and the important emphasis on linear connection means that orientation for daylight and views is not ideal in the Master Plan, but welcoming daylight into the buildings is a DoC goal, both for employee well-being and energy savings, with the following recommendations:

- Generous windows are assumed for the personnel-oriented spaces such as offices and workrooms, whether in research, administration or support buildings. High vertical window dimensions, paired with high ceilings are preferred, to maximize the daylight penetration.
- Windows should be appropriately shaded for their orientation to prevent glare. In general, enclosed offices and spaces should not be located along the windows; instead open work areas should face the windows.
- Recently, NIST has not introduced daylight into the research laboratories, although this should be discussed in depth when specific facilities are planned. Because research protocols are often sensitive to light and temperature variation, many researchers do not want windows in their labs.
- Some research laboratories, like those for the Communications Technology Laboratory, are computer oriented. Much like office space, these labs could benefit from natural light, but it is critical that glare, intensity and reflections be controlled.
- Windows, roof monitors and/or skylights should be used to illuminate circulation areas when practical.
- Daylight should be the primary illumination for the Management Resources Center, supporting its goal to be a net-zero facility.
- High performance glazing with high visual transmittance should be used.

Views to the Flatirons are magnificent and should be celebrated in building and site design. During the design of these buildings, internal organization and component locations will need to balance Flatiron views with the more immediate

Exhibit 101: Typical Campus Lyons Sandstone Façade Materials



view of the landscaped campus green. Designers should seek opportunities to capture Flatiron views for all, especially in shared use facilities such as conference rooms and the cafeteria. Both the Management Resources Center and the Childcare Center have the location and orientation to achieve this.

Façades

Façade guidelines are based on proportion and scale, areas that require focus, and the use of materials. The building façades facing the campus green and entry plaza will be important walls defining the outdoor spaces of the campus, and are thus of just as much importance as the ground plane in establishing the quality of these spaces.

Principles for façade design include several key considerations:

- Human scale: Because pedestrian circulation through the campus is encouraged, the building façades facing the important campus open spaces should maintain a design scale, rhythm, proportion, and detail related to the pedestrian.
- Response to context: An important design issue is the integration of the new buildings into the existing campus context. The massing guidelines begin this integration by requiring compatible building heights and footprints so as to maintain views and light to all buildings. Building façade materials can further assist this integration. The material palettes of the major buildings should be a mixed palette of natural stone, precast, glass and metal. Use of Lyons Sandstone is recommended—a local indigenous material used extensively in the Boulder area and on several campus buildings.

  Note that the Visitor Pavilion should not blend into Building 1, but should stand apart as a new addition to a historic building while respecting the original architecture. A glass façade is envisioned. (Refer to Secretary of the Interior's Standards for the Treatment of Historic Structures.)

- Response to environment: The orientation of the varying façades to the sun, and the effects of shading on the façade are important design determinants. Consideration of orientation represents a systematic and environmentally sound approach to building design. The building design responds directly to the environmental conditions with a corresponding reduction in energy use and operating costs.

10.3 Landscape Guidelines

The goal of the landscape approach and treatments is to unify the campus, minimize the irrigation and maintenance, and create a place richly evocative of the natural setting. Landscape guidelines, in the campus context, go beyond plantings, to include the campus walkways, site furnishings, and signage. The Landscape Chapter provides further description, definition and design intent for the items below.

Design Language

The design language for the landscape and campus green should blend a contemporary design aesthetic that expresses the technological research mission with a naturalistic aesthetic that emphasizes the “soft” features of the campus’s natural setting with ecologically functional plantings.

Hardscape

The design language for the hardscape is inspired by the warm colors and rugged durability of the natural stone and trails that surround the site. A combination of natural materials such as stone, gravel and crushed stones combined with durable constructed materials like corten steel, poured-in-place concrete, and unsealed asphalt all help to create a unified campus in harmony with its context. The use of materials and finishes that do not require frequent maintenance or repair is a priority. The rustic character will permit a high degree of weathering and wear before elements appear neglected. Cast-in-place concrete structures can have a rough-hewn appearance depending on the type of form work and finishing applied. The irregularities that appear in the surface of the concrete are desirable in the rustic vernacular. This design language is further expressed in these principles:

- Use Maintainable, Durable Materials: Use cost-effective materials such concrete with saw-cut joints, unit pavers, stone, crushed stone, and asphalt.
- Use Consistent Colors & Patterns: A consistent color palette of warm grays (in varying hues), browns, and rusticated steel provides a range of colors that are easily available across a range of materials.
- Vary Materials to Express Site Hierarchy: Different hardscape materials can express the hierarchy of spaces and pedestrian circulation, integrating wayfinding into the design itself. For example, the central promenade may use unit pavers in with a strong graphic pattern such as stripes while sidewalks and other secondary circulation can use scored concrete.
- Mix Hard and Soft Materials to Reduce Scale of Large Paved Spaces: Break up large expanses of hard paved areas with crushed stone joints, edging, or seating areas.

Gradient of Vegetative Zones

Creating a subtle gradient between the wild landscape surrounding the campus and the structured spaces of the campus itself is a key principle of this master plan. Three different vegetative zones are proposed here. Along the perimeter of the campus, a predominantly native zone is recommended. This zone would not be irrigated, so it would rely on clusters of pines and junipers which could be used for screening parking lots and adjacent neighborhoods. Two additional zones are envisioned for interior spaces between buildings. These more structured zones would still use native species, but the arrangement of the plantings would be more formal and structured. Exhibit 67 on page 67 in the Landscape chapter describes the placement and principles of each zone. Several guidelines are important for establishing this native-type vegetation:

- Use a high percentage of visual essence species: To relate the cultivated plantings to their natural inspirations, it is important to use large quantities of those plants that dominate native woodlands. Trees such as Ponderosa Pines and Rocky Mountain Junipers are critical components of the canopy layer. Grasses such as mountain brome (Ceratochloa carinata), needle and thread (Hesperostipa comata), green needlegrass (Nassella viridula), and mountain muhly (Muhlenbergia montana).
- Make the patterns visible: In order to make the natural patterns of the woodlands visible, it is important to create tighter, denser, and more exaggerated versions of the original. For example, if wild asters form loose drifts through a field of grass, then creating a thicker mass of five or seven asters will create a more robust, readable version than what happens in the wild.
- Restrain the height of plantings: Keeping grasses low (18-36") is an effective way to fit naturalistic plantings in campus contexts. Being able to see over mass plantings makes them more legible and appreciated.

10.4 Circulation and Parking Guidelines

The Master Plan proposes a change to the campus circulation system, retaining the loop roadway “behind” the major buildings and preserving the center of campus for pedestrian circulation and outdoor use. In general, parking areas are accessed from this loop road.

Roadways

Roadway design should be standardized for the entire DoC campus in terms of geometrics, curb profiles and pavements. The following are some of the specific recommendations:

- Intersection Geometrics: When possible, configure intersections with approaches perpendicular to one another at right angles in order to improve visibility for motorists, bicyclists, and pedestrians at the intersection.

- Roadway Cross-sections: The current roadway widths of 26 feet are adequate for campus use. This could be reduced to 24 feet in width, for newer roads. The corresponding lane widths will be 13 feet and 12 feet respectively. Standard six inch curbs with 18 inch gutters are recommended for use in most areas of campus[4]. Standard curbs provide the requisite protection and guidance for vehicles that may veer from the roadway potentially into pedestrian areas while providing needed channelization for runoff.
- Mountable curbs are only recommended in those locations where vehicles would be expected to cross the curb line on a regular basis (for instance near areas where trucks may need to mount curbs for maneuvering purposes or locations in which campus personnel or security may need to regularly access off-road areas). Curbs of 3-3/8 inches in height with 14 inch gutters are recommended, similar to those recommended in City of Boulder standards.
- Special Pavement Design: The central spine roadway between Buildings 3 and 26 (dividing the central campus green) should be limited to bicycle, pedestrian, and emergency traffic. It should be noted that this would cause some additional circulation for vehicles accessing the new parking garage behind Building 81 however, it would preserve the central part of the campus as a more pedestrian and bicycle oriented space. Textured pavement could also be used with speed tables incorporated to slow traffic should this roadway remain open to through traffic.
- Select pedestrian pathways (based on fire codes) should also adopt textured pavements and utilize construction that allows access by emergency vehicles as and when needed.

Parking

On-campus parking will be provided in existing surface parking lots, proposed lots near new buildings and a proposed two or three-level parking structure associated with new research building construction. The new parking structure is anticipated to be the primary parking for the new research buildings, located less than a 5-minute walk away from each. Accessible parking for people with disabilities should be located as close to the campus buildings as possible. On-street parking should be prohibited along all roadways.

The *First Amended Memorandum of Agreement* between the National Institute of Standards and Technology, US Department of Commerce and the City of Boulder, Colorado (May 1998) sets a limit on the number of parking spaces on the campus at 1802 spaces, which is not exceeded in the Master Plan.

Parking is a part of daily experience on campus and should be well organized with pedestrian walkways, shading and visual screening. Specifically these features:

- A high percentage of deciduous tree cover should be utilized to shade vehicles and reduce the heat island effect of large paved areas. Light colored paving and permeable paving should be used whenever practical.
- Parking structure design should seek to reduce energy consumption and enhance the user experience by introducing natural light through light wells and openings, and by utilizing natural ventilation.
- Electric vehicle charging stations should be included in the garage, in accordance with government regulations.
- Solar panels should be considered over the upper level of the parking structure and over existing/new surface parking.
- Parking lot design should optimize the layout for snow removal, considering plowing patterns and locations to pile the removed snow. Walkways must drain properly, to minimize icing.
- Best management practices for localized stormwater management should be incorporated.
- Pedestrian circulation should have dedicated walkways through the parking lots and parking structure.
- Temporary parking lots should be identified early in the planning for each construction project..

Bicycle Storage

The DoC Boulder Laboratories Campus has a fairly large number of bicycle commuters. Almost 18% of the respondents in the employee survey indicated that their primary mode of transportation is bicycle and almost another 7% are occasional bicycle commuters. Campus facilities personnel indicated that many of the bicyclists bring their bicycles to their offices against campus policy primarily because:

- Absence of bicycle lockers proximate to their offices
- Perception that the outdoor bike racks are insecure

The following guidelines are recommended:

4 These sections match those recommended in City of Boulder standards.

- New buildings and major renovations should integrate indoor bicycle storage spaces with direct access from outside. For larger buildings, multiple storage areas could be considered to improve convenience of access.
- Integrated bicycle storage areas should be secure and where possible, include individual lockable units.
- Shower and locker facilities proximate to integrated bicycle storage rooms should be considered.
- Bicycle racks shall also be provided close to building entrances.
- The total capacity of the indoor bicycle storage and outdoor bicycle racks should be equivalent to15-20% of the projected building population.

Bicycle and Vehicular Roadway Intersections

The campus frontage has two curb cuts on Broadway: the main campus entrance (Rayleigh Road) and the Medical Center Drive. A bicycle path runs along this frontage that intersects the curb cuts at both entrances at 90 degrees. The current configurations are not optimal as entering vehicles are unable to see approaching bicycles. It is recommended that the bike paths be reconfigured at both these intersections to encourage cyclists to slow down and to create a better line of sight for vehicles. The final alignment will be developed in consultation with the City of Boulder. Possible solutions might include chicanes (curves to slow riders), added signage, or signalization at the intersection. Grade separation is used in other Boulder locations, but would have significant cost implications.

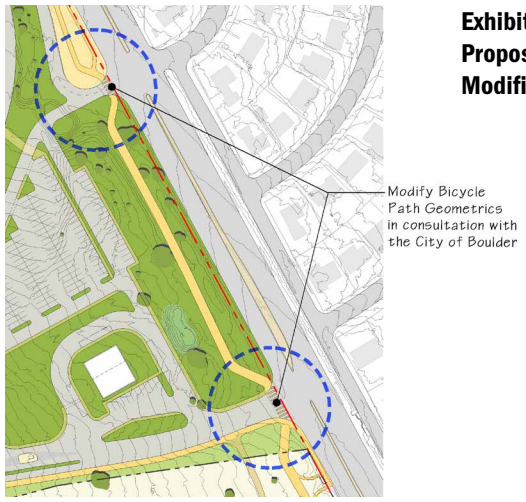


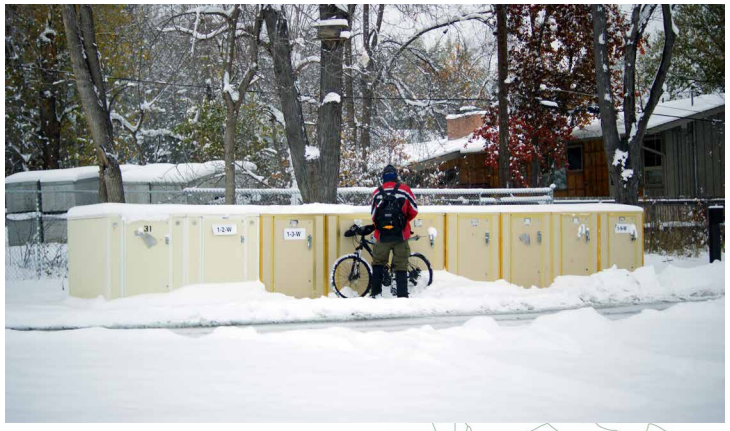
Exhibit 102:
Proposed Bicycle Path Modifications

10.5 Security Guidelines

The Department of Commerce Office of Security (OSY) is responsible for the physical security on the Boulder Laboratories campus, and must be included in the planning of the new and renovated facilities. Following is an excerpt from the OSY *Security Standards for Construction Projects*, in effect at the time of this Master Plan.

"Including the Security organization in the requirement development, planning, design and build out phase of all construction projects is essential to ensure physical security standards are considered to provide risk-managed protection to facilities, information and most importantly personnel. The inclusion of the Security organization within the early stages of design through construction ensures regulatory and risk based security measures and considerations are incorporated in the initial project requirement process and supplant the need for costly change orders that often have impact to budget, schedule or performance. The Security organization should review all related construction documents/drawings/specs and be included as a member of the construction project team from the early onset of the project. In addition, consultation with the Security organization facilitates early discussion and planning for contract employee background investigation and access requirements.

"For new construction and major renovations, the security organization must conduct a project-specific risk assessment during the requirements definition phase and recommend countermeasures and design features to be included in the design specifications. This risk assessment should include the proposed Facility Security Level of the facility, which will be used to identify minimum security countermeasures as recommended by the Interagency Security Committee."



Campus Analysis

11 Regional Analysis

11.1 Regional Context Overview

The Department of Commerce campus in Boulder, Colorado is located in the southwestern part of the City of Boulder, at the base of the Flatiron Mountains. The region in general and the City of Boulder in particular are widely recognized for an educated workforce, the University of Colorado Boulder (which is one of the nation's top ranked research universities), and a robust economy featuring diverse industries that include aerospace, bioscience, cleantech, IT/software, natural products and outdoor recreation. The regional setting of the campus, in many ways, has implications for its future development in many ways. This chapter describes the campus' regional contexts as it relates to:

- Geopolitical divisions
- Demographics and socio-economics
- Institutional environment
- Business environment
- Regulatory authorities
- Transportation infrastructure
- Built environment
- Natural environment

11.2 Geopolitical Divisions

Denver-Aurora Combined Statistical Area[5]: The United States Office of Management and Budget (OMB) has defined the Denver-Aurora, CO Combined Statistical Area comprising the Denver-Aurora-Lakewood, CO Metropolitan Statistical Area, the Boulder, CO Metropolitan Statistical Area, and the Greeley, CO Metropolitan Statistical Area. It consists of the counties of Denver (includes City of Denver), Arapahoe, Jefferson, Adams, Douglas, Broomfield (includes the City of Broomfield), Elbert, Park, Clear Creek and Gilpin. According to the Census Bureau's 2014 estimates, the Denver-Aurora CSA is the sixteenth most populous CSA in the nation.

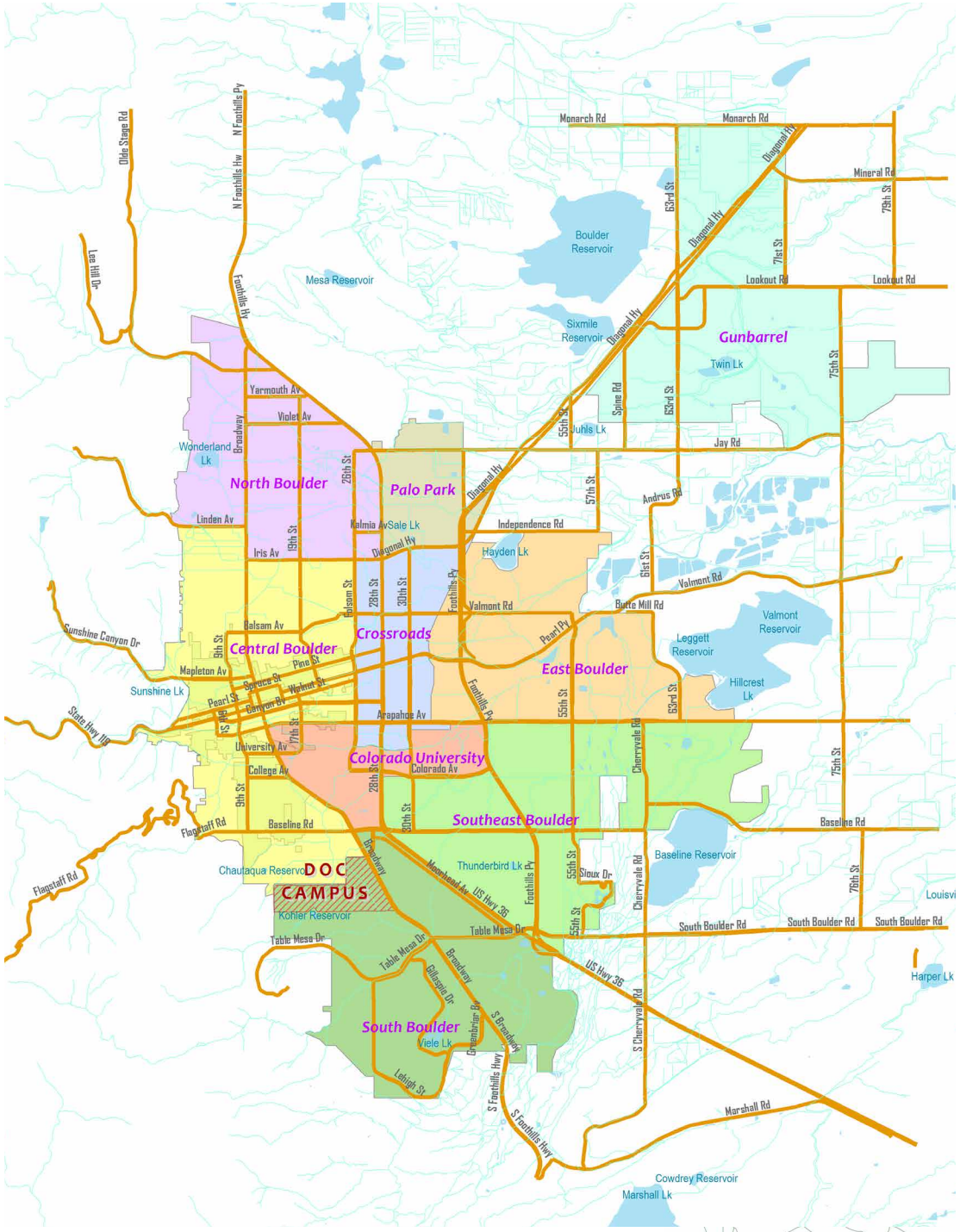
Boulder County: Boulder County is home to nearly 300,000 residents and includes some of the most diverse, natural landscapes and sustainable development along the Front Range. From visionary open space, land use and sustainability policies to forward-thinking public services programs, the county government helps foster a vibrant, healthy and active community. The county seat is the City of Boulder. Other incorporated towns and cities include: Erie, Jamestown, Lafayette, Longmont, Louisville, Lyons, Nederland, Superior, and Ward.

5 Combined Statistical Areas (or CSAs) are based on social and economic ties measured by commuting patterns between adjacent MSAs. Typically, each CSA is a collection of adjacent metropolitan/micropolitan statistical areas (MSAs). The primary distinguishing factor between a CSA and an MSA is that the social and economic ties between the individual MSAs within a CSA are at lower levels than between the counties within an MSA.

City of Boulder: The City of Boulder is the largest municipality in Boulder County, part of the seven-county Denver metropolitan area and the only county in the Boulder MSA (metropolitan statistical area). It is located about 30 minutes from downtown Denver and 45 minutes from one of the nation's largest international airports. Boulder has a vibrant economy representing a diverse array of industries, including aerospace, bioscience, cleantech, IT/software, natural products, outdoor recreation, and tourism. Besides those housed in the Department of Commerce Campus, the City also has about a dozen other federal research laboratories including the University Corporation for Atmospheric Research (UCAR).

Denver Regional Council of Governments (DRCOG): The Denver Regional Council of Governments (DRCOG) was created to foster collaboration and cooperation among the communities of Adams, Arapahoe, Boulder and Jefferson counties. It was created circa 1955 to talk about joint issues and concerns as the region was in the midst of a post-World War II growth spurt. It is one of the nation's three oldest councils of governments. The Council has instituted the Metro Vision regional growth and development plan, which defines goals and actions needed to ensure the vitality of the region. It is essentially a planning organization where local governments collaborate to establish guidelines, set policy and allocate funding in the areas of transportation and personal mobility; growth and development; and, aging and disability resources.

Exhibit 103: Regional Context Map



11.3 Demographics and Socio-economics

Population

The City of Boulder has a population of about 100,000. It has a sex ratio of 1.015 (i.e. 1,015 males to every 1,000 females). This is atypical, given that the nation as a whole has a sex ratio of 0.967 (i.e. 967 males for every 1,000 females). Also, the City of Boulder, and to a lesser extent the County of Boulder, has a relatively younger population when compared to the State of Colorado or the entire country. The median age of the City residents is 28.4 years compared to the 35.6 years for the County, 36.1 years for the State and 37.2 years nationwide—more than a quarter of the City's population are in their twenties. The City and the County also have a relatively higher percentage of their population in the 19 through 64 years age bracket compared to the state and the nation. Less than one tenth of the City's population is above 65 years of age compared to 11.1% for the state and 13.2% for the country. However, five-year average annual population growth projections indicate that the 60 years and over group is expected to have the highest rate of growth over the next 25 years[6].

The Denver-Aurora- Boulder Combined Statistical Area (CSA) is home to over 61% of the State's resident population although it comprises less than 13% of its land area. It is the sixteenth most populous of the 166 CSAs in the United States.

Exhibit 104: Population and Demographics Comparison

	United States	Colorado	Denver-Aurora-Boulder CSA	Boulder County	Boulder City
Total population	309,138,711	5,042,853	3,105,013	297,218	99,177
Male	152,018,799	2,529,614	1,546,983	149,296	49,955
Female	157,119,912	2,513,239	1,558,030	147,922	49,222
Sex Ratio (M:F)	0.968	1.007	0.993	1.009	1.015
Under 19 years	83,027,255	1,360,853	848,616	75,885	23,430
	26.9%	27.0%	27.3%	25.5%	23.6%
19 years to 64 years	185,440,015	3,123,657	1,941,573	191,175	66,825
	60.0%	61.9%	62.5%	64.3%	67.4%
65 years and over	40,671,441	558,343	314,824	30,158	8,922
	13.2%	11.1%	10.1%	10.1%	9.0%
Median Age	37.2	36.1	35.5	35.6	28.4

6 Source: The Denver Regional Council of Governments: Boulder Community Profile

Education

The Boulder Economic Council states that it has the "…most educated workforce in the U.S.". Over 70% of the population over the age of 25 have at least a Bachelor's Degree, and over 36% have graduate or professional degrees—significantly higher than the state or the national figures. As far as the population of 18-24 years is concerned, the percentage of the City and County residents with a Bachelor's degree or higher educational attainment is almost twice that of the nation.

The Boulder Valley School District has 56 schools spread over 500 square miles and has approximately 30,000 students and 4,000 employees. The University of Colorado, Boulder (CU-Boulder), which is proximate to the DoC Boulder Laboratories, is classified as a Research University[7]. It has over 90 research centers, institutes and laboratories and offers 3,400 courses in 150 fields of study. Among the University's faculty are five Nobel Laureates and four National Medal of Science winners[8].

Jobs, Employment and Income

The City of Boulder Department of Community Planning and Sustainability estimates that there are 102,500 jobs in the City as of 2013. About 41% of the jobs are held by City residents whereas 59% are held by commuters. Trends indicate that the City will have about 116,280 jobs by 2035[9].

Although the sizes of the labor force for the population over 16 years of age are comparable (based on census data[10]), both the City and County have unemployment rates that are lower than the CSA, the State and the nation.

The per capita income for City residents is almost 22% higher than the State and 35% higher than the national levels. The median household incomes for City residents are higher than the nation; and, percentage of households earning $200,000 or more per year is double that of the national levels.

Exhibit 105: Educational Attainment Comparison

	United States	Colorado	Denver-Aurora-Boulder CSA	Boulder County	Boulder City
Population: 18–24 Years	30,822,835	493,705	291,610	44,285	29,122
Less than High School	16.2%	15.9%	16.5%	6.5%	2.2%
High School or Equivalent	29.6%	27.9%	27.4%	16.6%	7.7%
Some College or Associates Degree	44.9%	45.2%	43.0%	59.8%	72.3%
Bachelor's or Higher	9.3%	11.0%	13.1%	17.2%	17.9%
Population: 25 years +	204,336,017	3,328,869	2,046,583	190,415	55,865
Less than High School	14.3%	10.1%	10.5%	6.0%	4.2%
High School or Equivalent	28.2%	22.4%	20.9%	12.7%	6.8%
Some College	21.3%	22.8%	21.7%	17.7%	13.5%
Associates Degree	7.7%	8.1%	7.4%	5.6%	4.2%
Bachelor's Degree	17.9%	23.4%	25.3%	32.4%	35.1%
Graduate or Professional	10.6%	13.2%	14.2%	25.6%	36.2%

Exhibit 106: Comparison of Unemployment Rates and Income

	United States	Colorado	Denver-Aurora-Boulder CSA	Boulder County	Boulder City
Population: 16 years +	243,810,053	3,955,983	2,420,537	242,172	86,663
In Labor Force	64.7%	69.5%	71.5%	70.3%	66.8%
Unemployment Rate	9.3%	8.0%	7.8%	6.9%	7.5%
Per Capita Income	$28,051	$31,039	$33,121	$38,283	$37,734
Medium Household Income	$53,046	$58,244	$62,384	$67,403	$56,206
Less than $25,000	23.3%	20.0%	18.6%	18.3%	25.8%
$25,000 to $49,999	24.1%	23.0%	21.8%	20.5%	20.3%
$50,000 to $74,999	18.2%	18.8%	18.2%	15.8%	14.9%
$75,000 to $99,999	12.2%	13.1%	13.3%	12.0%	10.0%
$100,000 to $199,999	17.6%	20.1%	22.1%	24.7%	19.7%
$200,000 or more	4.6%	5.0%	6.0%	8.6%	9.4%

7 RU/VH: Research Universities (very high research activity) in the Carnegie Classification of Institutions of Higher Education

8 Source: Boulder Economic Council

9 Source: 2014 Community Profile published by the City of Boulder

10 2012 ACS 5 year estimates

Housing

The ratio of housing units to the number of households for both the City and the County is about 1.06; this ratio is about 7% less than the national levels. This in part explains the low vacancy rates for the City and the County (5-6%) compared to the State or the Nation (about 11%). The 2010 decennial census data indicates a higher percentage of renter occupied units (52.3%) compared to owner occupied units in the City of Boulder compared to the County, the State and the Nation (35%-37%). This could at least partially be attributed to University of Colorado Boulder's students who opt for off-campus rental housing.

Majority of the City of Boulder housing stock is older than 35 years and almost a quarter of its stock was built in the 1970s. The median year of construction of the City's housing units is 1974. In comparison, the City's, the CSA's, and the state's housing stock has a median year of construction of 1980 while for the nation it is 1975.

In spite of the aging housing stock, the City of Boulder commands a median housing value of almost $490,000 which is significantly higher than the rest of the County ($354,300), the State ($ 248,800) or the Nation ($181,400). The City's median housing value is 8.7 times the median household income and 13 times the per capita income. This is very high compared to the national average (3.4 and 6.5 respectively), and the state (4.3 and 8.0 respectively).

Exhibit 107: Comparison of Housing Units and Tenure[11]

	United States	Colorado	Denver-Aurora-Boulder CSA	Boulder County	Boulder City
Total Housing Units	131,704,730	2,212,898	1,302,189	127,071	43,479
Occupied Housing Units	116,716,292	1,972,868	1,213,345	119,300	41,302
Vacant Housing Units	14,988,438	240,030	88,844	7,771	2,177
Owner Occupied Housing Units	75,986,074	1,293,100	783,653	74,993	19,695
Renter Occupied Housing Units	40,730,218	679,768	429,692	44,307	21,607

Exhibit 108: Comparison of the Age of Housing Stock

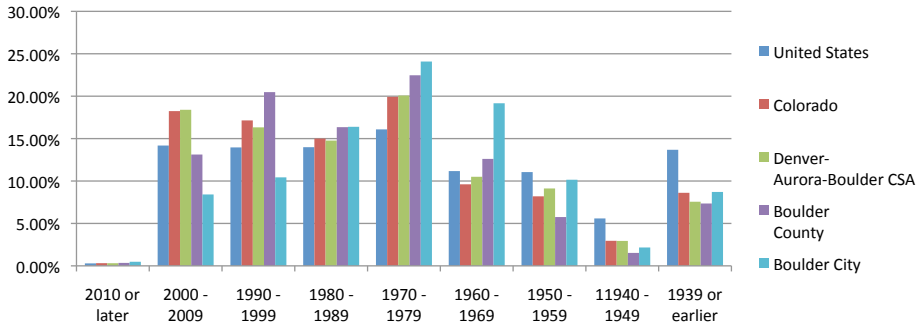
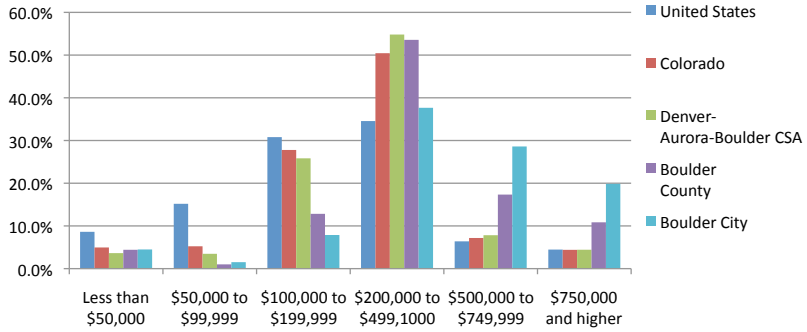


Exhibit 109: Comparison of Housing Values



11 2010 Decennial Census

11.4 Institutional Environment

University of Colorado, Boulder[12]

The University of Colorado Boulder (commonly referred to as CU Bolder) is a public institution founded in 1876, with a 600 acre campus located within the City of Boulder. It is the flagship of the University of Colorado system and the only school in the Rocky Mountain Region to make it into the Association of American Universities, an elite group of 62 research universities. The university has a proud academic tradition, with five Nobel laureates, eight MacArthur "genius grant" recipients, and more than 100 Fulbright fellows since 1982. CU-Boulder also has a long history of environmental awareness and has been ranked among the top "green" universities in the country.

CU-Boulder and NIST have a long history of collaboration, primarily through JILA, an institute that was founded in 1962 and is located on the CU-Boulder campus. Soon after its inception, JILA's research quickly expanded from its original astrophysics mission to include fields like atomic, molecular and optical physics, as well as biophysics, quantum information and precision measurement. Over the years, it has evolved into one of the nation's leading research institutes in the physical sciences.

Other Academic Institutions

- Colorado State University at Fort Collins
- University of Colorado, Denver with campuses in both Denver and Aurora
- Metropolitan State University of Denver at Denver
- Colorado School of Mines, Golden
- United States Air Force Academy at Colorado Springs
- University of Denver, Denver

Federal Agencies in and Around Boulder

The National Center for Atmospheric Research (NCAR) is the only other federal entity outside the Department of Commerce campus that has a significant presence in Boulder. NCAR is a federally funded research and development center devoted to atmospheric and related sciences. Its mission is to understand the behavior of the atmosphere and related physical, biological and social systems; to support, enhance and extend the capabilities of the university community and the broader scientific community—nationally and internationally; and to foster transfer of knowledge and technology for the betterment of life on Earth. The National Science Foundation is NCAR's primary sponsor, with significant additional support provided by other U.S. government agencies, other national governments and the private sector.

Other federal agencies that have a significant presence in the region (i.e. the Denver-Aurora-Boulder Combined Statistical Area) are:

- Environmental Protection Agency, Denver, CO, Lakewood, CO and Golden, CO;
- Two components of the U.S. Department of the Interior: Bureau of Reclamation, which is located in Denver, CO and the Bureau of Land Management (BLM) located in Lakewood, CO;
- U.S. Geological Survey's Colorado Water Science Center is located in Lakewood, CO.
- The Department of Veterans Affairs has the Veterans Affairs Chief Business Office Purchased Care (CBOPC) at the VA Health Administration Center, in Denver, CO. It also has several Veterans Benefits Administration offices in Lakewood, CO, and Fort Carson, CO, besides Vet Centers. The VA Eastern Colorado Health Care System(ECHCS) is also located in Denver, CO.

11.5 Business Environment[13]

Boulder features a diverse mix of industries of local, national and global importance. Certain industry clusters command a high employment concentration that includes aerospace, bioscience, cleantech, IT/Software, natural products, and outdoor recreation. In addition, key industries that provide economic impact to Boulder include tourism and research. The following provides briefs of some of these sectors in Boulder and the key organizations that spearhead them:

Aerospace: The aerospace industry has a long history in Boulder, dating back to the formation of Ball Aerospace and Technologies Corporation here in 1956. Ball Aerospace serves as an important anchor, serving civil, commercial, and military markets. Over

12 Source: US News and World Report: Education (http://colleges.usnews.rankingsandreviews.com/best-colleges/cu-boulder-1370)

13 Source: Boulder Economic Council

the years, Ball Aerospace has been joined by a number of other aerospace companies with a significant presence in Boulder, including NDP/Braxton, Lockheed Martin, Northrup Grumman, Special Aerospace Services, and Blue Canyon Technologies. Today, Boulder has a 5.2 times the national average in aerospace companies and entities that support the industry[14].

Bioscience: The bioscience industry emerged, in part, from research conducted at the University of Colorado Boulder. Over the past forty years, the area has developed a high concentration of companies (5.3 times the national average) in pharmaceuticals, biotechnology and medical devices and instruments.

Cleantech: The City has a host of companies that are environmentally friendly and businesses in the renewable energy and energy efficiency industries. There are 720 energy companies, and an employment concentration that is much higher than the national average.

Information Technology and Software: IBM established a 500 acre facility in North Boulder in the 1960s which initiated a strong technology and information economy in the City. The Boulder area has one of the nation's largest concentrations of IT employment and is home to two of the world's ten fastest supercomputers. It has the highest "high-tech startup density" of U.S. metro areas[15].

Natural Products: The City has the nation's largest concentration of natural and organic products companies and has the highest per capita consumption of organic foods in North America, according to the International Federation of Organic Agriculture Movements.

Outdoor Recreation & Tourism: The City is a destination for active lifestyle and outdoor recreation enthusiasts. It is home to a several businesses involved in the outdoor recreation industry including manufacturers, distributors, retailers, and service providers. According to the Boulder Convention and Visitors Bureau 2013 *Economic Impact of Tourism*, the estimated number of jobs in the City of Boulder attributable to tourism is 7,533, including 6,241 jobs directly tied to the tourism industry.

Exhibit 110: Comparison of Industries Employing Residents[16]

	City of Boulder	Boulder County	Colorado	United States
Educational services; health care and social assistance*	25.50%	23.00%	20.20%	23.00%
Professional, scientific; management; administrative	21.20%	20.60%	13.60%	11.10%
Arts, entertainment, recreation; accommodation, food services	15.40%	10.60%	11.00%	9.70%
Manufacturing	8.50%	11.30%	7.10%	10.50%
Retail trade	9.90%	10.20%	11.30%	11.60%
Other services	5.40%	4.90%	5.00%	5.00%
Construction	1.60%	3.60%	7.20%	6.20%
Finance, insurance; real estate, leasing	3.40%	4.20%	7.00%	6.60%
Public administration	2.10%	2.60%	4.80%	4.70%
Wholesale trade	1.70%	3.10%	2.60%	2.70%
Information	3.10%	3.20%	3.00%	2.10%
Transportation and warehousing; utilities	1.60%	2.20%	4.60%	4.90%
Agriculture, forestry, and fishing; mining	0.50%	0.60%	2.60%	2.00%

*Includes universities and public schools
US Census, 2013 American Community Survey (based on NAICS codes)

Based on the Market Profile published by the Boulder Economic Council, the City of Boulder has approximately 7,000 employers with 5 or more employees. Its ten largest employers (listed in alphabetical order) are:

- Ball Aerospace
- Boulder Community Health
- Boulder County
- Boulder Valley School District
- City of Boulder
- IBM
- Medtronic/Covidien
- NOAA
- UCAR/NCAR
- University of Colorado Boulder

14 Source: University of Colorado Business Research Division (2013)
15 August 2013 Kauffmann Foundation Report
16 Source: 2015 Market Profile published by Boulder Economic Council

11.6 Local Regulatory Authorities

The DoC Boulder Laboratories is a federal campus and is generally exempt from local regulations. However, DoC, like many other federal agencies, practices a "good neighbor" policy and generally complies with the applicable local regulations. The following are some of the key regulatory bodies that have jurisdiction in the area.

City of Boulder: The City of Boulder has the primary land use jurisdiction within its borders including building permits, code enforcement, planning and zoning. It also has other responsibilities as summarized below:

- The City's Community Planning and Sustainability (CP&S) Department is tasked with comprehensive and strategic planning responsibilities, conducting development reviews, and applying sustainability principles for new development and redevelopment.
- The Code Enforcement Unit, which is part of the City's Police Department, responds to property maintenance and nuisance code violations that affect public safety and quality of life in the City of Boulder.
- The City's Historic Preservation program helps preserve the community's unique heritage, culture, and character by protecting physical assets from Boulder's past.
- The Transportation Division of the City is responsible for transportation planning and operations including GO Boulder17, project management, transportation maintenance and Boulder Municipal Airport operations. The Transportation Division is also responsible for maintenance of the City's Transportation Management Plan.
- Open Space & Mountain Parks Department manages, preserves and protects the City's 145 miles of trails and 45,000 acres of land, wildlife habitat, unique geologic features and greenways. The Open Space Board of Trustees and City Council is charged with preserving land for scenic, agricultural and buffer value. With public input, the Board approves acquisitions that are funded through sales tax revenues, bond issues, private donations and development dedications.

Boulder County: Although the County is not responsible for land use related regulations within the City of Boulder, it has jurisdiction in terms of flood plain management and assessments. It is part of the National Flood Insurance Program and is responsible for reducing flood hazards, regulating floodplain activities, adopting floodplain policies, mapping floodplains, and educating the public about floods and floodplains. It also provides criteria and design standards for the many different conditions within the Urban Drainage and Flood Control District. Besides floodplain management responsibilities, the County also is responsible for property assessments, managing appeals regarding property values and for property tax abatements.

Regional Transportation District (RTD): Organized in 1969, the RTD is the regional authority responsible for operating public transit services in eight of the twelve counties in the Denver-Aurora-Boulder Combined Statistical Area in Colorado. RTD currently operates a bus and light rail system and is constructing the voter-approved FasTracks rapid transit expansion that will add 122 miles of new commuter rail and light rail, 18 miles of bus rapid transit service, 21,000 new parking spaces at rail and bus stations, and enhance bus service across the eight-county district.

Colorado Department of Transportation (CDOT): The Colorado Department of Transportation builds and maintains interstates, US highways and state highways. CDOT conducts snow and ice operations, roadway maintenance and preservation, and construction management as their primary activities. In addition, it also provides traffic monitoring, avalanche control, rockfall mitigation, transit development and grants,

and traffic safety education for impaired driving, teen driving, distracted driving, work zone safety, seat belts and more.

11.7 Natural Environment[18]

The Boulder Valley sits between the Flatirons section of the Rocky Mountains and the western edge of the Great Plains at an average elevation of 5,430 feet above the sea level. The 31 mile long Boulder Creek that runs through the valley drains the nearby mountains as well as the surrounding plains. Thus the Boulder Creek Watershed is a natural "container" encompassing some 440 square miles and extending from the Continental Divide to the high plains. In the mountains, Boulder Creek passes over granitic and metamorphic rocks that aren't very reactive; when it moves into the plains, the geology is dominated by sedimentary rocks, including sandstones and shales.

The City of Boulder as well as Boulder County consider the natural environment a critical asset for the region and make efforts to preserving and protecting the same through its plans and policies.

11.8 Built Environment

The City of Boulder has a compact urban form comprised of predominantly low-rise and some mid-rise development. It has a mix of residential developments ranging from pre-World War II era to more recent Neo-Traditional and New Urbanist housing. Non-residential uses range from commercial retail, industrial, research and institutional uses all connected through a robust multimodal transportation infrastructure. The form of the City is strongly influenced by the foothills of the Flatirons on the west and the greenbelt to the north, east and south. The City has a centrally located historic core (about 3 miles northwest of the Department of Commerce Campus) with a string of pre-World War II neighborhoods. The City has a retail corridor north of Arapahoe Avenue along 28th Street. The university and the Federal campuses of DoC and NCAR are on the southern part of the City. The industrial areas are to the east and the newer residential areas are to the north.

18 Source: Boulder Area Sustainability Network

11.9 Transportation Infrastructure

Airports: Boulder Municipal Airport is a general aviation airport, less than five miles from the DoC campus. It provides business, private, recreational and emergency aviation services to the surrounding communities but does not offer commercial airline service. The nearest commercial airport is the Denver International Airport (referred to as DIA), about forty miles from the DoC Campus. It is the fifth busiest airport in the United States serving approximately 53 million passengers per year. The DIA is connected to the region through the SkyRide bus system which operates year round. The AB SkyRide Route connects Boulder to DIA, with a stop on Broadway at the front of the DoC campus.

Road Network: The City of Boulder has three major highways, generally running in the north-south and north-south-southeast directions. The State Highway 93 (which has other local designations for different segments) passes along the western side of the City and eastern boundary of the DoC campus. The segment along the DoC campus is designated as S Broadway. The Denver-Boulder Turnpike runs north south (designated as 28th Street for an extended length) almost centrally within the City and then towards southwest towards Denver. The Turnpike is also designated as Federal Highway 36 beyond Boulder County. State Highway 157 also runs north south, east of 28th Street, and merges into the Boulder-Denver Turnpike near the southern limits of the City. To the north, it meets Diagonal Highway, which is also designated as State Highway 119.

The primary thoroughfare in the east west direction is State Highway 7, also designated as Arapahoe Road. West of 28th Street, the major east west connection is Canyon Drive also designated as the continuation of State Highway 119.

Public Transit Network:

- Bus Network: Within the Regional Transportation District (RTD), there are four separate route systems. The SkyRide system connects the DIA to the regional population cores. The Local/Limited routes are generally confined within each of these population centers; the Express Routes run along specific corridors; and, the Regional Routes connect the population centers. Boulder is connected to several of the regional population centers through the Express service.
- FasTrack: This is a multi-billion dollar public transportation expansion program administered by the RTD consisting of new commuter rail, light rail, and express bus services. The longest of the FasTrack projects, the Northwest Rail Line is planned to be a 41-mile fixed-guideway transit line to Longmont from Denver passing through Boulder. The first segment of this line operating from Westminster to Denver Union Station opened on July 25, 2016.

11.10 Regional Planning Environment

The Boulder Valley Comprehensive Plan (BVCP) is a collaborative effort between the City of Boulder and Boulder County that informs and guides the planning and development in the Boulder Valley. The current plan was originally adopted in 1977 and is currently undergoing its seventh major update which will be completed in 2016. As stated in the City's website, "the BVCP policies guide decisions about growth, development, preservation, environmental protection, economic development, affordable housing, culture and the arts, urban design, neighborhood character and transportation. The policies also inform decisions about the manner in which services are provided such as police, fire, emergency medical services, water, utilities, food control and human services". It also establishes the desired land use patterns including type and intensity of development.

Campus Land Use Designations: The Department of Commerce campus has multiple land use designations, as noted in the 2010 Boulder Valley Comprehensive Plan Land Use Designation Map:

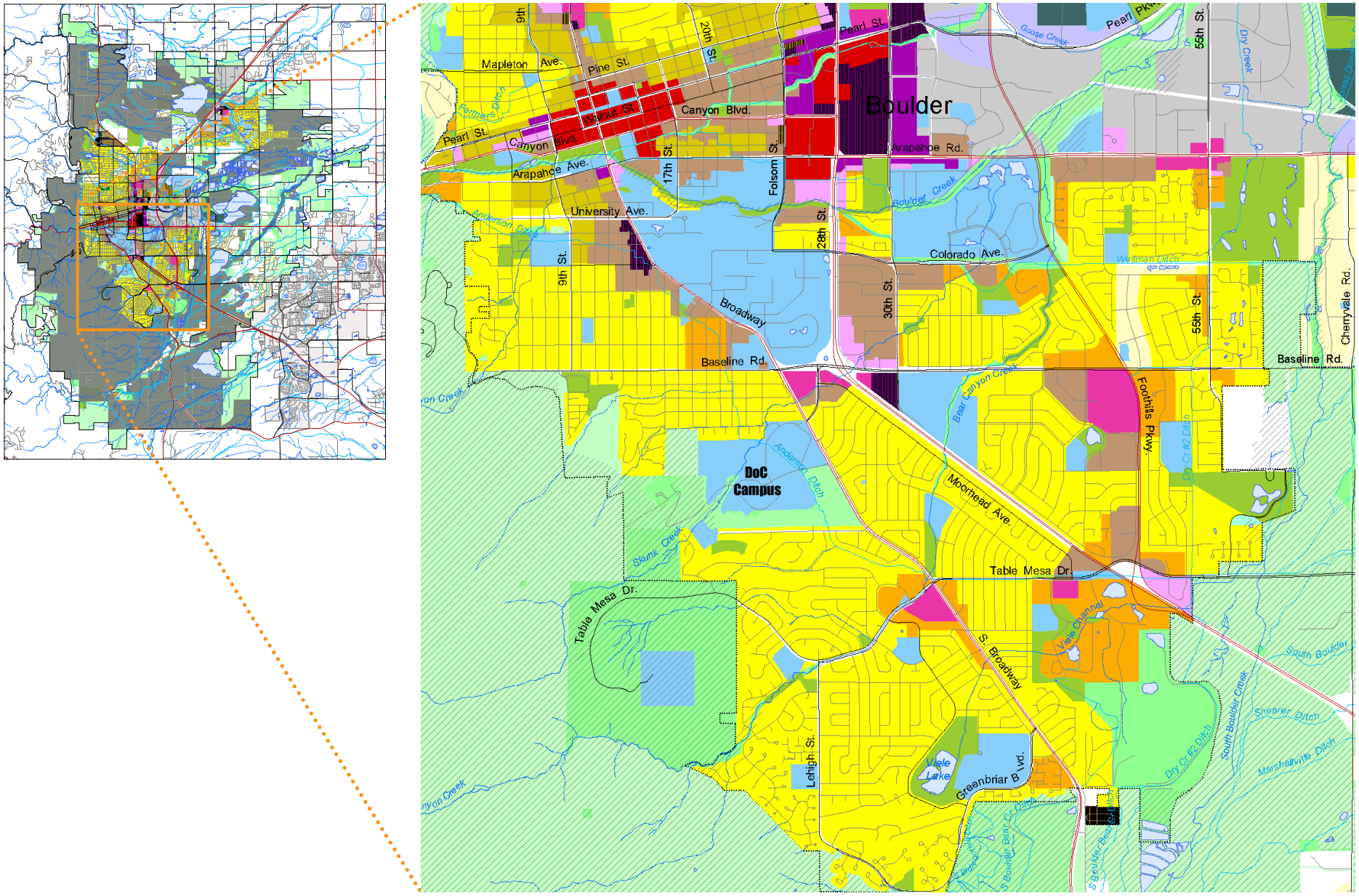
- Majority of the developed areas and their immediate surrounds (Research Zone 2 and Research Zone 3, shown on the Existing Site Plan) are designated as *Public Use*, referring to a wide range of public and private nonprofit uses that provide a community service and includes government laboratories ;
- The Tribal MOA Protected Area is designated as *Open Space, Development Rights*, referring to Privately owned land with conservation easements or other development restrictions; and,
- The Research Zone 1 or the mesa, is designated as *Open Space, Other*, referring to public and private land designated prior to 1981 that the city and county would like to preserve through various preservation methods including but not limited to intergovernmental agreements, dedications or acquisitions.

Surrounding Land Use Designations: The campus mostly has Low Density Residential (two to six units per acre) land uses to the north, east and south. To the west, the land use is *Open Space, Acquired*.

A medical office use sits on a single parcel to the north of the campus on Broadway which shares a boundary and has an access easement through the campus. This parcel is zoned RL-1 or Low Density Residential. Its land us designation has been recently changed from Transitional Business to Low Density Residential, as well.

Boulder Transportation Master Plan: The City of Boulder's Transportation Master Plan (TMP), represents the transportation policy and strategy directions to support the broader community goals identified in the Boulder Valley Comprehensive Plan. The Transportation Master Plan documents both vehicular and non-motorized infrastructure in the City as well as its usage. It outlines a framework for transportation related investment and proposed transportation projects. The key features of the City's TMP include recognition of walking as a fundamental method of travel, with an emphasis on developing a robust non-motorized transportation and transit infrastructure. To that end, the City's plan focuses on limiting the vehicle miles traveled (VMT) as its population grows.

Exhibit 111: Boulder Valley Comprehensive Plan Land Use Designation Map



11.11 Significance for the Master Plan

Although seemingly self-contained, the Department of Commerce campus is an integral part of a larger economic, environmental and scientific community. Specific considerations for the Master Plan include:

- **The City and County of Boulder.** The City and County work together to create forward-looking policies on land use, transportation, sustainability, stormwater, construction and recreation. Their goals and regulations are coordinated across multiple departments and clearly stated in the Boulder Valley Comprehensive Plan. The City has shown interest and willingness to work with the DoC in crafting their future plans and advancing specific projects.
- **Transportation.** Boulder has a strong public transportation infrastructure, and an even stronger bicycle path network, both of which serve the DoC campus. Many employees and associates use public transportation or the network of designated and protected bicycle routes. Incorporating and strengthening these systems will benefit both the campus and the employees.

- **Environmental awareness.** Sustainable design, energy and water conservation are on the minds of Boulder residents and underlie many of the policies and regulations of the City. The DoC Boulder Laboratories has demonstrated awareness, such as xeriscaping and solar site lighting. The Katharine Blodgett Gebbie Laboratory received Gold LEED certification for its design and construction. The community and City would welcome additional consideration and strategies in the Master Plan.
- **Open space and parks.** The DoC property is integrated into the trail and recreation system maintained by the Boulder Open Space and Mountain Parks Department. Boulder Mountain Park abuts the property to the west, and Tibbet Open Space to the north. Trails from both these recreation areas cross the property, and trail modifications/ upgrades are planned by the City.
- **Institutional and hi-tech environment.** Advanced and related research is conducted at the University of Colorado, which is located down the street, and at the National Center for Atmospheric Research, also located in Boulder. These institutions, as well as five other academic institutions and several hi-tech businesses in the region, enrich the scientific dialog and interaction that NIST wants to encourage.
- **Residential neighbors.** The residential neighbors in Boulder are affluent, well-educated and concerned about their environment and housing values. They will be interested in planned actions at the DoC campus. The DoC held a public meeting during the Master Plan development process, and the community had the opportunity to comment on this document and the environmental assessment that accompanies the Master Plan.

12 Campus Site Analysis

THE campus for the Department of Commerce Boulder Laboratories is approximately 206 acres in size, configured roughly in an L-shape. The entrance and buildings are oriented toward the east, bordering on Broadway, which is Colorado State Highway 93. The remainder of the property is surrounded by residential development and recreational land, with a cemetery bordering the campus at the north. The land gently rises toward the west, culminating in a steep rise to Kohler Mesa at the western end of the property. Two ephemeral water bodies transect the site, Skunk Creek and the Anderson Ditch, an irrigation channel. Much of the property is designated Open Space, protected from development under a Memorandum of Agreement with the City of Boulder together with an association of Native American tribes.

The site presents opportunities and constraints that have influenced its development, and will shape any future growth or change. These influences fall into two categories: Natural Characteristics; and Development Characteristics. The natural characteristics are those inherent in the land itself in its current state, such as topography and water features. The development characteristics are either regulatory or operational in nature, such as zoning regulations and security requirements.

Courtesy NIST

12.1 Natural Characteristics

Topography

The City of Boulder and the Department of Commerce campus lie in the eastern foothills of the Rocky Mountains. To the west of the campus, the dramatic Flatirons rock formation rises above to frame the view. The eastern edge of the DoC campus lies at an elevation of 5,405 feet, and rises gently across the developed areas of the site. The slope increases more rapidly to the west of Skunk Creek, rising up to Kohler Mesa, at an elevation of 5,910, which is 505 feet higher that the campus entrance at the eastern edge.

Hydrology and Water Resources

Watershed

The DoC campus is within the Boulder Creek Watershed, a 440 square mile area extending from the Continental Divide to the plains east of the City of Boulder. It is in the designated Skunk Creek Basin. Skunk Creek is one of fifteen tributaries that drain into Boulder Creek, and an important drainage channel in this area of the City. Stormwater and flood management are critical in Boulder, and the City has prepared a Comprehensive Flood and Stormwater Utility Master Plan with specific mitigation recommendations and requirements. Management of stormwater in the watershed is complicated by its urbanized nature and susceptibility to flash floods. (Source: *Comprehensive Flood and Stormwater Utility Master Plan*, City of Boulder, October 2004)

Surface Water

Skunk Creek and Anderson Ditch are the two waterways that transect the campus. Skunk Creek is an intermittent stream, located to the west of the DoC buildings, at the foot of Kohler Mesa. The creek normally does not have flowing water except during storms. The stream flows across the campus from the southwest to the northwest. The stream experienced some erosion from the storm and ensuing flood of 2013.

The Anderson Ditch is an irrigation channel, establish in 1860 by Jonas Anderson and Marinus Smith. Drawing water from Boulder Creek, it once irrigated 425 acres. It is owned and operated by the Anderson Ditch Company and holds an easement through the DoC campus. Today, NIST is one of the shareholders in the Ditch Company, although the city of Boulder is the majority shareholder[19]. Release of water through the Ditch is controlled upstream, and it flows from the northeast corner of the site through the campus to the south. Anderson Ditch is located in the midst of the campus developed area, and is enclosed and partially covered in the area of the Precision Measurement Lab (Building 81), and open throughout the remainder of the property. NIST is responsible for the maintenance of the Ditch on its property, under a 2007 agreement with the Ditch Company. In consultation with the Ditch Company, NIST restored the ditch in 2014 after a major flood by removing sediment and widening the Ditch slightly in selected locations. Anderson Ditch is the source of water for the campus irrigation system.

Flood Plain

The Federal Emergency Management Agency (FEMA) is the official source for Flood Insurance Rate Maps, which identify areas subject to flooding for flood management planning and insurance underwriting. These maps are developed by studying data for river and stream flow, storm tides, hydrology, topography and rainfall. The current 2012 FEMA map for the campus shows a small portion of Building 81 within the 100-year floodplain, as well as Skunk Creek and the road to the north of Building 5.

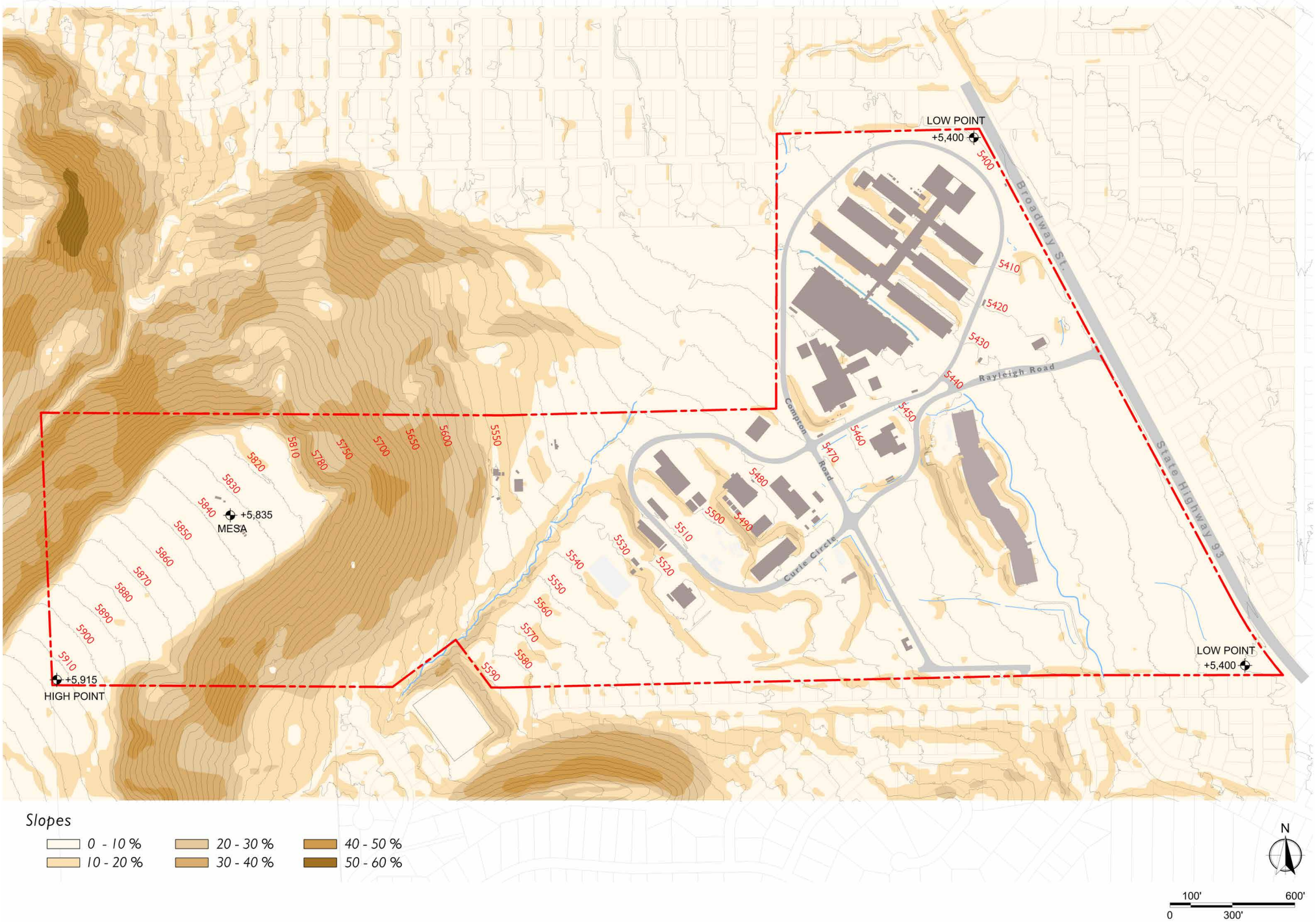
The campus and the City of Boulder experienced a serious flood in September 2013 resulting from a rainstorm that dropped 18" of rainfall in 8 days—called the 1000-year flood by many. There was significant damage in Boulder, despite the City's preparations. On the Department of Commerce campus, flood waters inundated several basements.

After the flood, the Water Resources Board of the City of Boulder commissioned a floodplain mapping study that included Skunk Creek. The mapping study was based on 2013 flood information, theoretical flash flood modeling, and updated topography mapping developed by using Light Detection and Ranging (LiDAR) technology. Significant topography changes incorporated into the study results. A new floodplain map was proposed.[20] This map was awaiting City Council approval at the time of this report, after which it will be used for regulatory purposes. The new mapping will be submitted to FEMA for review and inclusion in their Flood Insurance Rate Maps.

19 The Ditch Project; Accessed May 31, 2016. http://bcn.boulder.co.us/basin/ditchproject/?Our_Ditches:Anderson_Ditch.

20 Skunk Creek, Bluebell Canyon Creek and King's Gulch; Request for Physical Map revision (PMR) by City of Boulder, Draft August 2014.

Exhibit 112: Slopes



The City-proposed Skunk Creek Floodplain Mapping indicates a change for the DoC campus. Building 81 would no longer be in the 100-year floodplain. However, the proposed floodplain surrounds Building 1C and a portion of Building 1-Wing 1, and extends over the adjacent parking lot north to the campus edge. The proposed floodplain map indicates two designated areas within the larger 100-year floodplain: the Conveyance Zone, for the passage of flood waters; and the High Hazard Zone, where there is a potential for people to be swept off their feet. City of Boulder's Code has restrictions on development, building additions/modifications and new parking in the floodplain—more restricted for the Conveyance and High Hazard Zones. (Boulder Revised Code, Chapter 9-3-2: Floodplains)

Stormwater

Stormwater flows from west to east across the campus with the terrain, from both the DoC property and upland areas beyond. Some of the stormwater is collected in underground piping, which connects to a City of Boulder municipal system. However, the majority flows into two campus water bodies, Skunk Creek and Anderson Ditch. Stormwater from both Skunk Creek and Anderson Ditch flows to Bear Canyon Creek, although at different locations—Skunk Creek to the north of campus and Anderson Ditch to the south. Bear Canyon Creek drains into Boulder Creek approximately two miles south of the campus.

As part of the system, the campus has several non-structural, or natural, stormwater control measures to detain the stormwater and slow or lessen the amount of water flowing off-site. There are two detention basins in the southeast Protected Area and several smaller areas, including two along Broadway, one by the northern pedestrian gate and another by Building 3.

Boulder Laboratories, with its Municipal Separate Storm Water System, holds a permit from the US Environmental Protection Agency, meant to protect runoff quality and prevent harmful pollutants from being discharged untreated into local waterbodies. This permit, called an MS4, meets the requirements of the National Pollutant Discharge Elimination System (NPDES). To support the permit, the DoC has prepared a Stormwater Management Plan (SWMP), which outlines information, actions and training to meet the permit terms and protect water quality.

The purpose of the permit and the SWMP is to eliminate or reduce pollutants that are carried by stormwater into the receiving streams. The SWMP identifies actions and responsibilities for campus personnel, and includes six minimum control measures (MCM) and the Best Management Practices (BMP) that support them. The six MCMs' are:

- Public Education and Outreach on Storm Water Impacts;
- Public Involvement/Participation;
- Illicit Discharge Detection and Elimination;
- Construction Site Storm Water Runoff Control;
- Post-construction Storm Water Management for New Development and Redevelopment; and
- Pollution Prevention and Good Housekeeping for Municipal Operations.

The MS4 permit and SWMP are an important consideration for the Master Plan. The SWMP includes best management practices to control runoff, spills and leaks waste disposal, construction practices, and raw material storage. Proposed development of one acre or more must be permitted by EPA. The Energy Independence and Security Act requires all development or redevelopment on federal facilities to install best management practices to meet predevelopment hydrology in terms of flow rate, volume, temperature and runoff duration. A key issue for the campus is controlling and offsetting the addition of impervious surfaces, recognizing the significant amount of paving that exists, most without trees or vegetation to control runoff.

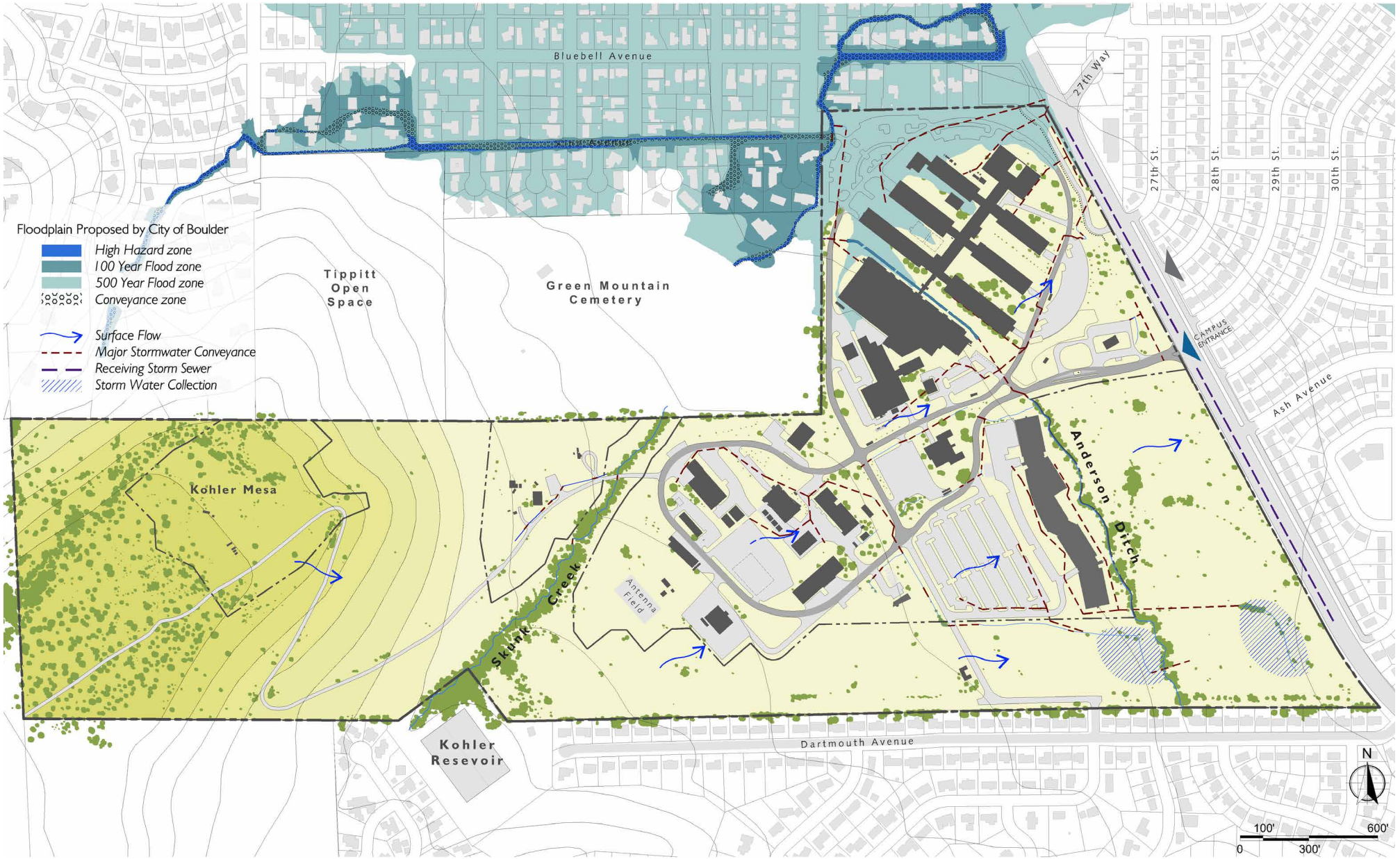
Natural Ecosystems, Vegetation and Wildlife

The Department of Commerce Campus is part of the Montane Woodlands and Great Plains Mixed Grass Prairie natural ecosystem, according to the Boulder Valley Comprehensive Plan. Natural ecosystems zones, as defined by City of Boulder, supports native plants and animals or possess important ecological, biological, or geological values. They may also contain features that are rare, unique, or sensitive to human disturbance[21].

The western part of the site falls within the "Group Two Natural Ecosystem Zone" which is generally considered important in providing ecosystem connections and buffers. Although there may be human-altered landscapes in these zones, the area may still retain significant populations of species of concern

21 Source: City of Boulder and Boulder Valley Comprehensive Plan

Exhibit 113: Hydrology



or function to meet biological requirements for species of concern (e.g., reservoirs).

The 1996 Environmental Impact Statement for the campus notes that of approximately 1,500 species of vascular plants occuring in the Boulder region, nearly 430 species, representing 77 families, have been identified on the DoC campus. It also notes that the campus vegetation was severely disturbed in the mid-1950s and non-native species replaced much of the native vegetation. In the 1990s, the dominant species were nonnative grasses and forbs that escaped from cultivation and landscaping which included Kentucky bluegrass, cheat grass, orchard grass, and crested wheatgrass. Non-native weedy annuals, biennials and perennials were also prevalent. Native plants, mostly grasses such as switchgrass, Canada wild rye, and western wheatgrass were sparsely distributed on the campus and constituted less than one percent of the total vegetation cover. Box elder, cottonwood and green ash were the main shrubs found along Anderson Ditch and Skunk Creek.

The Boulder Laboratories campus has a large number of ash trees, notably lining the Anderson Ditch in front of the David Skaggs Research Center. Ash trees in Colorado are suffering from an infestation of the Emerald Ash Borer, a federally quarantined invasive tree pest that feeds on and destroys ash trees. DoC has taken some preventative action, but expects to lose most or all of their ash trees over time.

The Mesa served as a transition area for prairie and mountain plant species containing stands of Ponderosa pine and other plants like big bluestem, pasture sage, Canada bluegrass, prairie dropseed, needle-and-thread, cinquefoil, prickly pear and rose. There are some introduced herbaceous species present, including sunflowers. Some pine regeneration was found to be occurring in the 1990s.

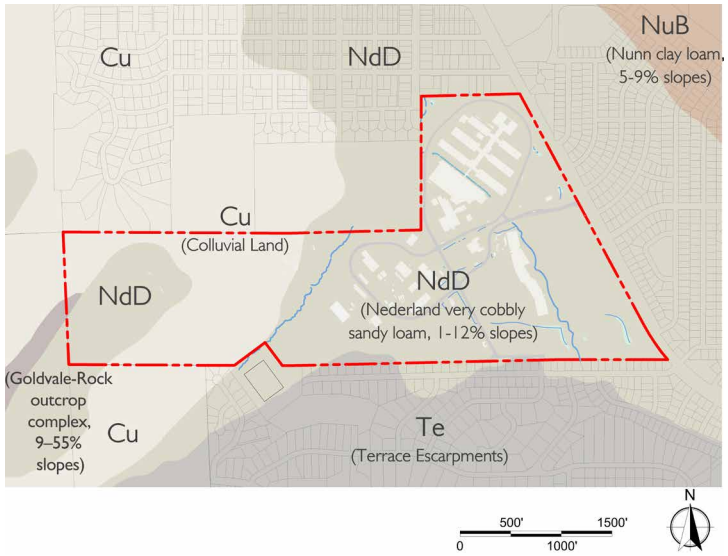
The United States Fish and Wildlife Service (USFWS) conducted faunal surveys in 1992 on the campus which included the Skunk Creek drainage and adjacent uplands, Anderson Ditch and adjacent areas, and the Mesa. It was concluded that mammal species, such as mountain lion, black bear, and beaver, were likely individual rare transients whereas coyote, bobcat, and red fox, were uncommon. Common animals spotted were yellow-bellied marmot, prairie dog, cottontail, mice, and shrews. While the site is within the historic range of such species as peregrine falcon, bald and golden eagles, on-site nesting could not be confirmed. Amphibians such as leopard frogs, chorus frogs, woodhouse toads, and tiger salamanders were also common[22]. Local residents have reported seeing additional species.

Geology and Soils

The campus, not unlike the extended region east of the Rocky Mountains, is underlain by Pierre shale geologic formation or series, formed in the Late Cretaceous period.

The predominant soil type on the campus is Nederland (NdD) which covers over 80% of the site including all of the campus area east of Skunk Creek outside the Tribal Protected Area. The NdD soils are deep, well drained, moderately permeable soils formed in very cobbly and gravelly alluvium derived principally from granite. These soils, which allow slow to medium runoff, are generally conducive to development although the presence of stones and cobbles can impede some excavations.

Exhibit 114: Soils



West of the Mesa, there is a wide section of Colluvial Land (Cu) soils covering about 17% of the site. Colluvial soils are highly variable in depth, texture, color and stoniness and consistently exhibit high erosion potential. The erosion potential impedes even low-intensive improvements, such as paths and trails.

Two other types of soils cover the remaining three percent

22 1996 Environmental Impact Statement for NOAA and NIST

of the campus, namely Goldvale-Rock (GrF) along the west boundary and Terrace Escarpments (Te) along the south boundary east of Skunk Creek. GrF soils are characteristically well drained, allow medium to rapid runoff, and feature slow permeability. Terrace Escarpments are unconsolidated in nature and typically feature steep slopes. The presence of silts and clays in terrace escarpments can easily make them unstable when development activities occur on or near this landform.

Climate

Boulder Colorado, which has an average altitude of 5,400 feet above sea level, has a predominantly semi-arid climate. July is usually the warmest month of the year averaging daytime temperatures of 87°F. January is the coldest, with an average daytime high of 45°F. On an average, there are 4-5 nights in a year when temperature reaches 0 °F. Snowfall averages 88 inches per season, but snow depth is usually shallow; a strong warming sun due to the high elevation can quickly melt snow cover during the day and Chinook winds bring rapid warm-ups throughout the winter months. Prevailing wind directions are from the south, north, and south-southwest.

Exhibit 115: Monthly Mean Temperature[23]

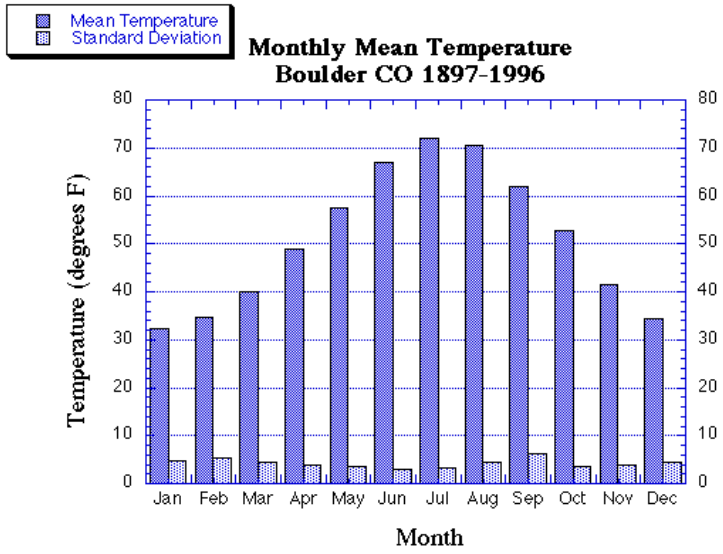


Exhibit 116: Monthly Precipitation[24]

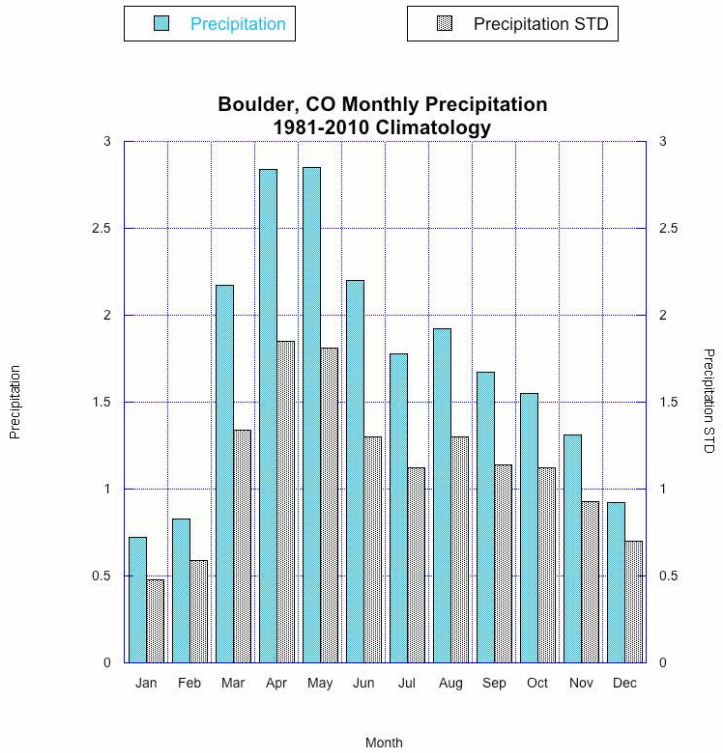
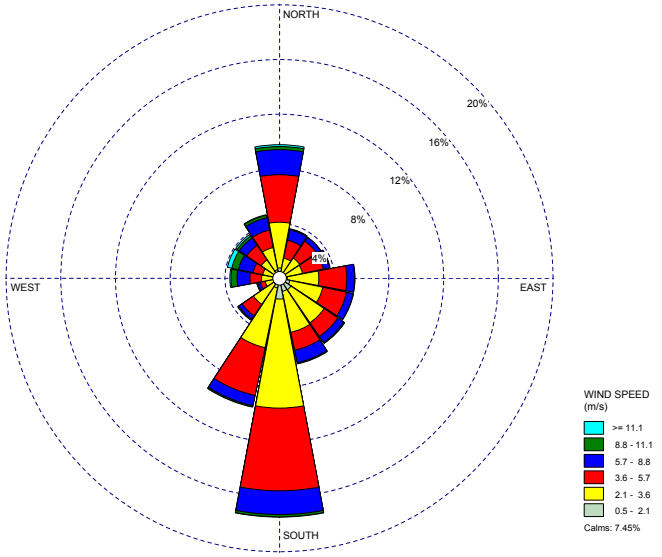


Exhibit 117: Wind Speed Direction



23 NOAA/ESRL PSD

24 NOAA/ESRL PSD

Sustainable Design Opportunities

Successful integration of sustainable design strategies will require a comprehensive framework in the Master Plan, and a targeted approach for each project that results from it. The Department of Commerce, like other Federal agencies, strives to save energy, conserve resources and limit pollution. Following are standards and executive orders to be considered:

- Department of Commerce *High Performance and Sustainable Buildings Handbook*, February 2011
- Department of Commerce *Implementation Handbook for the Strategic Sustainability Performance Plan*, June 2013
- NIST *Sustainable Design Manual*, July 2014
- US Executive Order 13693: *Planning for Federal Sustainability in the Next Decade*; March 2015
- CEQ's *Guiding Principles for Sustainable Federal Buildings and Associated Instructions*; February 2016
- US Energy Independence and Security Act of 2007 (EISA 2997)
- US Energy Policy Act of 2005 (EPAct 2005)
- The Energy Independence and Security Act (Public Law 110-140) of 2007

The Boulder Laboratories already embrace many of the principles of sustainable design in the campus elements and operations. Much of the campus is preserved and protected in its natural state, open to community use and protecting Skunk Creek. Landscape irrigation water is drawn from the Anderson Ditch. Transportation alternatives are supported, including extensive use of public transportation and bicycle commuting. Solar collectors are used for site lighting.

The Master Plan recommends other opportunities for incorporating sustainable design strategies into campus development and future buildings.

- Enhance strategies for stormwater quantity and quality control, including reducing impervious surfaces and utilizing plantings where possible to increase ground water recharge rather than runoff
- Enhance campus-wide energy performance by consolidating small inefficient buildings
- Facilitate and augment the already established bicycle and public transit use
- Incorporate daylighting into building design for offices, support spaces and selected laboratories. Utilize strategies to reduce glare and solar heat gain on the building envelope through building orientation, design and screening with vegetation.
- Maintain and increase tree cover to moderate temperatures, shade buildings and outdoor activity areas and absorb pollutants
- Explore the potential for incorporating photovoltaics into the site design, e.g. solar field, parking cover, rooftop installation

Exhibit 118: Campus Impervious Surfaces

	Research Zone 1 (SF)	Research Zone 2 (SF)	Research Zone 3 (SF)	Protected Area (SF)	Total (SF)	Total (Acres)
Impervious Areas						
Buildings	1,100	5,400	608,400		614,900	14
Antenna Field			20,100		20,100	0
Other Structures/Areas		2,500	84,000	1,700	88,200	2
Utility Yard			70,500		70,500	2
Parking/Loading Areas	1,800	5,000	725,900		732,700	17
Road/Side Walk	31,700	18,900	492,700	173,000	716,300	16
Total Impervious Areas	**34,600**	**31,800**	**2,001,600**	**174,700**	**2,242,700**	**51**
Total Pervious Areas	**476,800**	**277,900**	**1,627,400**	**4,333,800**	**6,715,900**	**154**
Total Site Area	**511,400**	**309,700**	**3,629,000**	**4,508,500**	**8,958,600**	**206**

12.2 Development Characteristics

The visual character of the campus is dominated by the terrain—the natural landscape, Kohler Mesa, and the Flatirons beyond. Both by design and regulation, the buildings are low in scale, appearing as foreground elements before the views. The buildings step back from Broadway, following the gradually rising slope. The majority of the site is preserved as designated Open Space, and characterized by low mixed grasses and intermittent trees. Riparian vegetation marks the paths of the Anderson Ditch and Skunk Creek across the property.

Surrounded by residential and low-scale commercial development, the campus is easily recognized, with no visual buffer from Broadway, which is a main thoroughfare. Two buildings

are prominent when approaching the campus, Building 1–Radio Building, and Building 33–NOAA's David Skaggs Research Center. The two largest campus buildings, they represent two eras of laboratory construction. The Radio Building, built in the 1950's, is a concrete and stone panel building with six wings linked by a multi-story spine. Renovation of two wings and a portion of the spine was recently completed. The 1999 David Skaggs Research Center is a long linear building of four stories, clad in local stone and brick.

Campus Organization

While there are three designated "research zones" in accordance with the MOA with the City of Boulder, two of these are restricted in their use. The largest, Research Zone 3, is also designated as the Development Zone. Within the Development Zone, the campus can be loosely organized into three districts, based on physical characteristics and typical uses. The road structure is a very strong campus organizing element, reinforced by changes in grade. The three campus zones do look different from each other, and there is very little feeling of linkage or functional relationship.

The laboratory district is the cluster of buildings by Broadway, anchored by the Radio Building and encompassing the original campus buildings and most of the labs, including the recent state-of-the-art Building 81. This area is defined by an enclosing loop road, called Compton Road and Marconi Road. Laboratory buildings are close together, connected and characterized by multiple additions and annex buildings. One lab building, Building 24, is an outlier from the loop road.

The support district is to the west, also enclosed by a loop road, the Curie Circle. Located here are the Central Utility Plant and various administration and support buildings, and one lab building, Building 3. NIST is currently modernizing and expanding Building 3 into a major research facility. This area houses distinct individual buildings, typically one-story in height. Many of these buildings are modular buildings or temporary buildings that have taken on permanent status. Each building has its own adjacent parking area.

NOAA's buildings and parking form the third district. This roughly triangular parcel is to the south of the site along Anderson Ditch. Although not physically separate from the rest of the campus, maintenance of NOAA's area is managed by the U.S. General Service Administration. The primary structure is

Exhibit 119: Functional Districts

the David Skaggs Research Center; in addition, a large parking lot and an observatory building are terraced up the slope.

With limited land available in the laboratory zone, the support zone is a likely location for future NIST development. Buildable parcels are available, and the low and temporary buildings offer the opportunity for future consolidation of administrative and support functions. Additional buildings are possible in the laboratory zone if phased construction replaces existing older buildings.

One of the challenges of the Master Plan is the integration of more distant research buildings into the hub of scientific activity, for a cohesive and comprehensible campus. NIST has developed a conceptual "center of scientific influence" to help define the levels of lab technology and organize lab assignments. This center is designated to be at Building 81, the new Katharine Blodgett Gebbie Laboratory, and defined as the core of intense lab infrastructure, with specialized infrastructure that links and supports other laboratories.

Campus Circulation

The Boulder campus has a single vehicular entrance from Broadway, which is Colorado State Highway 93. All employees, visitors and deliveries use the same entrance. The Security Center, Building 51, is located as one enters the campus, where visitors, delivery personnel and their vehicles are screened. Employees use an adjacent lane and enter with their ID badges. The single campus entrance is well marked with prominent signage. However, some confusion is caused by an entrance drive just south of Building 1 that leads to a privately-owned building located adjacent to the campus.

Vehicular Circulation

Branching off from the entrance, two loop roads characterize the main campus circulation. Compton Road and Marconi Road circle the area occupied by the majority of the research buildings. A second loop, Curie Circle, services the building to the west of the campus, as well as access to the NOAA building parking area. The roads are well maintained, and offer easy access to the various parking lots. Evaluation of circulation patterns identified several areas of conflict to be addressed in the Master Plan, including the following:

- **Congestion at the campus entry.** Visitors and their vehicles must be screened upon entry into the campus. Space and maneuvering room are limited, and congestion is a problem. See the security description in this chapter.
- **Conflict at entrance.** A City designated bike route passes along Broadway and the campus entrance. It is heavily used, and often by speeding bicyclists. Conflicts occur at the campus entry drive.
- **Conflict near Building 81.** The two loop roads are connected by a short drive, located between Building 81 and Building 33. This 50-foot long segment supports drivers turning from four directions, including visitors from the entry drive who must make a decision at this point. This intersection is very confusing, and there is no signage to assist. The road radius is not adequate for large trucks, and curb damage has occurred.
- **Dangerous conflict at the Childcare Center.** A pull-off lane and parking area are provided for parents who are dropping off their children for daycare. Cars then exit the parking onto a blind spot on Curie Circle, just beyond a right-hand curve for cars coming from the entry road.
- **Conflict at the Warehouse–Building 22.** The parking area at the warehouse is shallow, at approximately 56 feet. There is little maneuvering room, and the staff temporarily closes this section of Curie Circle when tractor-trailers are backing in or extending into the roadway.
- **Signage.** Directional signage is lacking at decision points along the campus roadways.

Pedestrian and Bicycle Circulation

Employees arrive at the campus by car, bicycle and public bus. Parking is available in open lots near each building.

Many employees at the campus commute on bicycles year-round. Although no statistical information is available, a high percentage of summer time riders has been reported (anecdotally, 30%). The number of bikes observed inside lab and office areas (not permitted) suggests that the current amount of protected bicycle storage is not adequate. Bicycle racks, bike lockers and bike rooms are located in and around campus buildings. There are 62 bike lockers on campus: 42 lockers located north of Building 81, 12 lockers located south of Building 81, and 8 lockers near Building 24. In addition, racks for 152 bicycles are available on campus.

The Regional Transportation District operates bus lines along Broadway and along 27th Way, stopping at the two bus stops at the Boulder Laboratories campus. There is no convenient walkway from the bus stops to the campus buildings.

Campus Paths and Trails

Pedestrians, both employees and the public, have free access to the site for recreation. There are two pedestrian gates from adjacent residential areas, and trail access from parkland at the western edges of the property. The City of Boulder has established an extensive integrated network of walking and bicycle paths throughout the city, and hiking trails in the nearby mountain parks. Several of these pass through the Boulder Laboratories campus.

Designated Bike Route. Part of the City-wide system, a public bicycle route has been established through campus, maintained in an arrangement with the City of Boulder. The route covers most of the roads on the campus, beginning at the Broadway entrance, following Rayleigh Road, looping around Buildings 2, 81 and 1, and extending to Curie Circle, where it connects with a City multi-use path west of Buildings 4 and 5.

Exhibit 120: Circulation

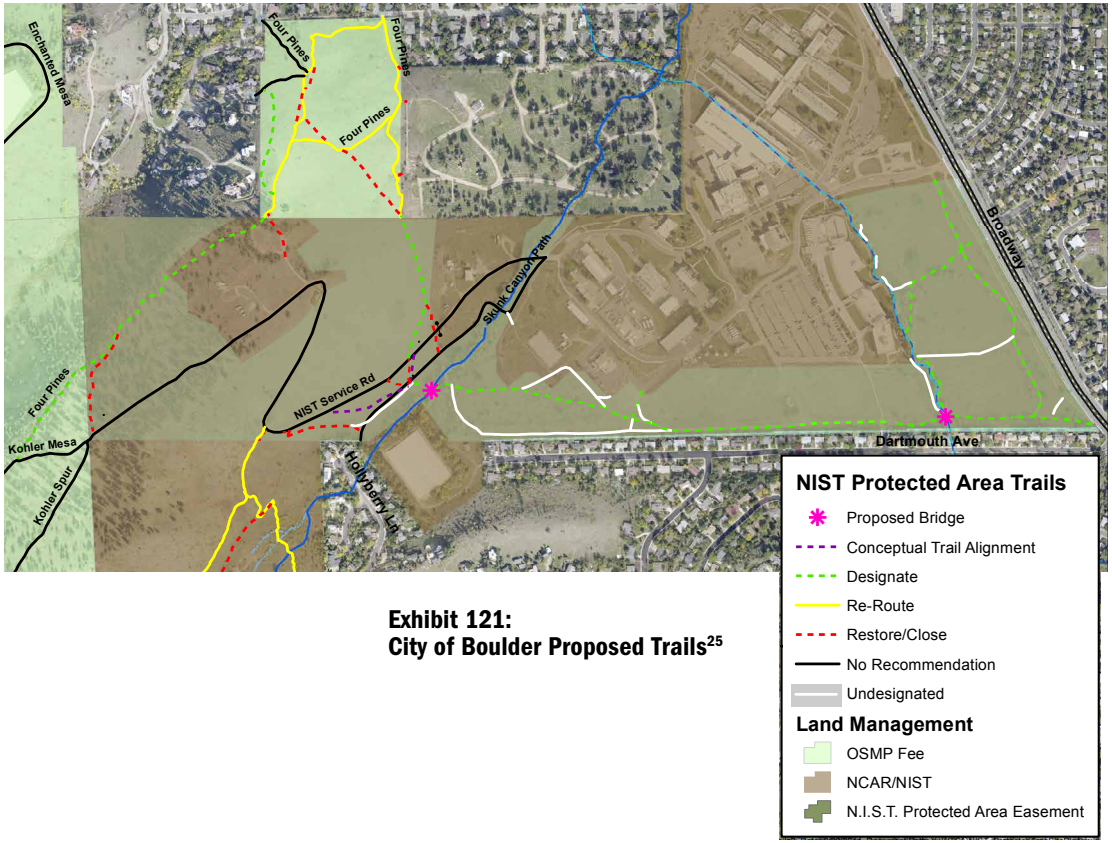


Exhibit 121:
City of Boulder Proposed Trails[25]

Multi-Use Paths. The City designates multi-use paths for shared use by pedestrians, bicyclists, skaters and other non-motorized uses. They are pathways physically separated from street and traffic. Two main multi-use paths are on campus, connecting to the designated bike route noted above. One of these paths runs parallel to Broadway, marked for pedestrians and bicyclists and separate from the street. The second runs along Skunk Creek, connecting Curie Circle with a bike path at the south property line that links to Table Mesa Drive.

Campus Trails. The City's Open Space and Mountain Parks group maintains hiking trails throughout City parkland and designated Open Space. The trail systems through the campus Protected Area make use of DoC's Kusch Road. It links the campus roadways to Kohler Mesa and Boulder Mountain Park to the west. Four Pines trail at the western edge of the property connects Boulder Mountain Park to the Tippitt Open Space along the north property line[26].

NIST is engaged in a collaborative project with Boulder's Open Space and Mountain Parks (OSMP) to create a designated environmentally sustainable trail system. The City is responsible for maintaining the Protected Area and is concerned with issues of erosion, landscape protection and safety. Following are the anticipated actions[27]:

- Designate trails between Skunk Creek and Broadway, closing undesignated trails and restoring them to their natural state.
- Construct two new trails connecting Greenways multi-use path to Kusch Road, closing and restoring related undesignated social trails.
- Evaluate options to cross Skunk Creek.
- Work with the Anderson Ditch Company to design and install a crossing.
- Designate trail connections to Four Pines and Kohler Mesa.

Deliveries

Mail and delivery trucks go through screening at the Visitor Center-Building 51, and then proceed to the Warehouse-Building 22. Both deliveries and pick-ups are processed here. Government vehicles are used to move packages and mail to the various campus buildings. Scheduled deliveries of large equipment or bulk items, such as construction materials, are often driven to the receiving building by the outside delivery truck. Under an interagency agreement, NOAA staff manage the mail and delivery services for all organizations on the campus.

Campus Landscape

The developed campus landscape consists primarily of lawn and suburban-style planting beds, creating a visual hodgepodge of disconnected landscapes unrelated to the campus Open Space. There is the opportunity to use plantings to unify the campus and create a richer sense of place in harmony with its larger context. The Ponderosa Pine Savanna that surrounds the campus is beautiful, and ecologically resilient, and it is a signature feature of the larger Front Range landscape. Plants of this community

25 Source: City of Boulder website; Map of Bike & Pedestrian Routes, and Map of Open Space Trails

26 Source: City of Boulder website; Map of Bike & Pedestrian Routes, and Map of Open Space Trails

27 Source: City of Boulder Open Space and Mountain Parks website

can help to unify the campus, minimize irrigation and maintenance, and create a place richly evocative of the natural setting. This basic palette of plants can be patterned in a variety of ways—highly naturalistic arrangements to more formal compositions—depending upon the specific context.

Existing Plant Character. The existing campus is open in character. Trees are scattered throughout, but nowhere is there continuous canopy. The ground plane is composed of a random combination of lawn, ornamental plant beds, and low meadow-like grasses. The presence or absence of irrigation greatly influences the quality and character of the planting.

Tree issues. Existing pine trees seem to thrive on the site. Some of the most significant stands of deciduous trees include the ash trees planted along the Anderson Ditch. Many of the ash trees suffer from Emerald Ash Borer, an infestation that will likely result in the decline of those trees. This prompts the need to create a campus-wide arboricultural management plan as well as to diversify the canopy and select more resilient species.

The landscape surrounding the campus should create a needed sense of continuity and place on campus. A well designed landscape that harmonizes with the larger natural setting can serve as living connective tissue that ties together the disparate pieces of architecture and surface parking.

Campus Security

The perimeter of the campus is open to adjacent streets and residential area, without a surrounding fence. Several trails cross the campus, and the neighbors use the site for recreation, jogging and biking to downtown or the university. NIST controls all vehicular access to the property at the entrance from Broadway, where visitors' cars and delivery trucks are screened. Other than the screening of vehicles, campus security is at the building level, with access control and hardening of the exteriors.

Visitors who plan to enter any campus building must stop at the Security Center to be screened and receive a badge and escort. A visitor parks next to the Security Center building, and enters to be issued a visitor badge and have the magnetometer screen any possessions brought into the building. If the visitor does not bring in any possessions (briefcase, bag etc.), but leaves them in the car, the items are not scanned. Also, the visitor is screened only on the initial day of a multi-day pass.

Because of the building's small size, visitor flow is not efficient. On a typical day, approximately 100–125 visitors are screened.

All non-employee vehicles are screened. Vehicles pull into the Security Center parking area, where officers/guards visually inspect vehicle contents, using handheld mirrors and cameras when appropriate. Campus security also checks with the NIST employees that are sponsors for any deliveries. The building and vehicle inspection area are close to the Broadway entry, limiting queuing space and constricting flow. Security issues at the entrance include:

- Visitor parking, car and truck inspection are conducted in the same area, and maneuvering room is very limited. It is not possible to parallel process a tractor trailer and passenger vehicle, so traffic can back up into the campus entry at busy times.
- Space is needed for large trucks to pull off the main circulation and park for further inspection where they will not interrupt the flow.
- Visitor parking is no longer allowed in the lot behind the Visitor Center because the exit from this lot bypasses vehicle inspection. Cars must then circle around via the main drive.
- The distance from the entrance booth to the security bollards is not long enough space to allow the person at the inspection booth be able to react and raise the bollards in time to stop a breaching vehicle.
- Operational issues, including limited scanning of visitor possessions, and no secondary validation of driver identity at the entrance booth
- Signage is not sized or positioned such that it can be read by first-time visitors.
- As a Federal property, Federal laws apply and are in conflict with Colorado regulations that allow concealed firearms and marijuana. Visitors may inadvertently have these items in their vehicles, which then can't be allowed onto the property and can't be parked at the entrance.

Employees use a separate traffic lane when entering the campus, using their IDs to open a gate.

Regulations Governing Site Development

Memorandum of Agreement

Much of the Boulder Laboratories Campus is protected from development through agreements with the City of Boulder and a collective of Native American tribes. In 1993, the US Department of Commerce and the US General Services Administration entered into an agreement to protect campus land with fourteen Native American tribes and the Medicine Wheel Coalition for Sacred Sites of North America. Recognizing overlapping easements, this earlier agreement was folded into the *First Amended* MOA *between the National Institute of Standards and Technology*, U.S. *Department of Commerce and the City of Boulder*, signed May 8, 1998.

This Memo of Agreement (MOA) protects specific areas of the campus from development, and sets limits on site usage and future buildings. Key provisions that affect the Master Plan are the following:

Campus Development Zones

The *Development Zone* is an 83.31 acre area where all building is to take place, and where the existing major research buildings are located. (This is also referred to as Research Zone 3.) Within this area, the Government may maintain existing buildings and build new ones, subject to certain restrictions.

Buildings may not exceed 55-feet in height, when measured in accordance with Section 84 of the Boulder City Charter, and the height must not impair the view of the top one-third of Kohler Mesa, as seen by a person standing on Broadway. Any proposed variations of this must be presented to diverse community groups for review.

- Total square footage of all buildings is limited. Originally, the maximum square footage was set at 1,187,270 gross square feet. This was adjusted by NIST and the City of Boulder in a March 2015 letter to account for new measurement methodologies, and is now set at 1,418,923 gross square feet as measured by GSA and the Building Owners and Managers Association (BOMA)[28].

	Existing	Permitted
Buildings	1,254,174 GSF	1,418,923 GSF
Parking	1,430	1,802 spaces

- Parking spots are capped at a total of 1,802 spaces. Parking areas are to incorporate landscape treatments that help them to better blend into the natural environment.
- Buildings must comply with national and local building codes.

Research Zones 1 and 2 are designated areas that currently support outdoor research and several small buildings. Kohler Mesa is Research Zone 1, at 11.74 acres. Research Zone 2 is located in the north-central part of the campus, by Skunk Creek, and is 7.11 acres in size. No new habitable buildings are permitted in Research Zones 1 and 2, but the existing buildings may be redeveloped if similar in use, size and height.

The *Protected Zone* encompasses approximately one-half of the campus land, and incorporates the areas protected under agreement with the Tribes. The 103.5 acres begins in front of NOAA at Broadway, extends across the southern portion of the property and the western third, excepting the top of Kohler Mesa. In the Protected Zone, no research will be conducted.

- The public has access and the Native American Tribes are permitted to hold gatherings in their protected areas.

28 Jane S. Brautigam, City Manager to Virginia Holtzman-Bell, Boulder Laboratories Site Manager; March 15, 2015; Boulder Colorado

Exhibit 122: Views

- No new perimeter fencing is permitted in this zone without the written permission between the parties and the Tribes, if adjacent to their easement.
- Utility and communication lines may be placed beneath the protected area.
- Pedestrian and bicycle paths exist, and are to be maintained by the City. No new paths are to be created.
- A portion of Anderson Ditch is located in the Protected Zone, and the government is allowed to use this for irrigation.
- Two detention ponds for stormwater are permitted and have been built in the southeast area of the campus.

Other Development Considerations

- The Department of Commerce must keep the community informed when any construction in undertaken.
- City of Boulder will review any proposed building over 10,000 gross square feet in size, reserving a 30-day review and comment period to consider a full range of issues.
- In accordance with the National Environmental Policy Act (NEPA), DoC must complete requisite environmental review and documentation.

Easements

The Boulder Laboratories Campus is encumbered by several easements in addition to the restrictions of the MOA: 1) The City of Boulder has an easement with NIST for the creation of the Protected Areas; 2) The Department of Commerce is responsible for the repair and maintenance of the Anderson Ditch, which has an easement though the campus running between Building 81 and Building 1, and then south into the protected area; 3) The owner of 385 Broadway holds an easement for the property's entrance drive, which is a turn-off from Broadway; 4) The City of Boulder has a pedestrian and bikeway easement along Broadway Street. The City also has easements for utility and communication lines, one along the north property line, as well as several in the protected area; and 5) The Regional Transportation District (RTD) has a license for bus shelters on NIST property along Broadway.

City of Boulder

The Boulder Laboratories Campus is located within the City of Boulder. Owing to its federal ownership, the campus is generally exempt from local regulations and plans. The Federal Government, through the General Services Administration (GSA) has instituted the "Good Neighbor Program" to ensure quality work environments for the employees of federal agencies by helping to revitalize the nation's communities[29]. Executive Order 12072 also requires that "Federal facilities and Federal use of space in urban areas shall serve to strengthen the Nation's cities and to make them attractive places to live and work. Such Federal space shall conserve existing urban resources and encourage the development and redevelopment of cities."

29 Source: GSA Public Buildings Service Publication" GSA's Good Neighbor Policy"

Exhibit 123: Analysis—Campus Issues

13 Campus Built Environment

THE Department of Commerce Boulder Campus is approximately 206 acres and contains 34 permanent and temporary structures that support the research mission, 29 of which are occupied buildings. These buildings represent a spectrum of uses, from laboratory buildings to offices to garages. Eight buildings remain from the initial campus development in the 1950's including the Radio Building, representing approximately 35% of the total campus space. There was little additional construction until 1999, when a major building for NOAA was completed. NOAA's David Skaggs Research Center and subsequent construction over the last 15 years now represent approximately 58% of the total space. Many campus buildings, both old and new, are modular construction or small, simple buildings. Three buildings—the Radio Building, the Katharine Blodgett Gebbie Laboratory and the David Skaggs Research Center—represent over three-quarters of the campus space.

13.1 Functional Observations

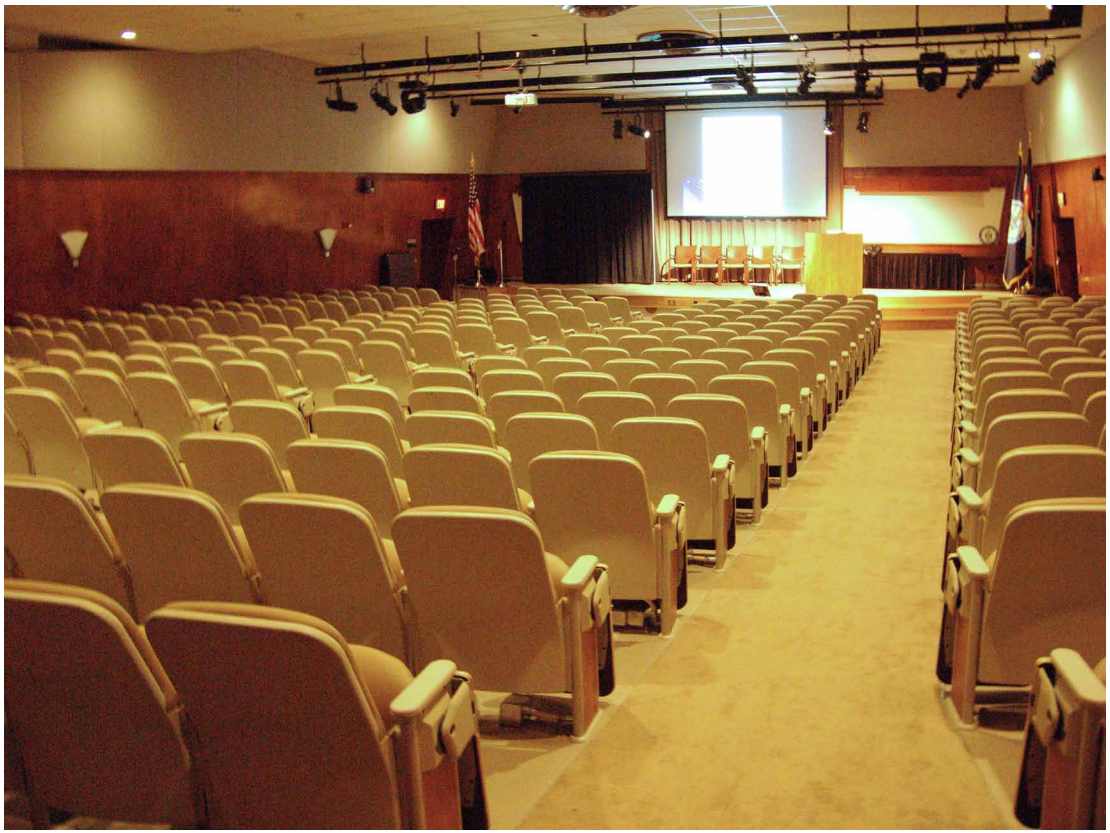
Campus buildings are well maintained, and repairs are made when necessary. A 2012/2013 facility condition assessment of the NIST buildings and grounds, *Facility Assessment, Sustainability Study* by Nelson Engineering, identified physical deficiencies, and recommended repairs to each building. Many of these were implemented, or are planned for upcoming projects. While the total repair backlog is significant and the majority of the buildings received a Facility Condition Index (FCI) score in the poor range, there are several buildings that scored as fair to good. The assessment also pointed out the aging nature of many buildings, especially the smaller ones, and the inefficiency of multiple, older engineering systems.

Inefficiencies are not only in the physical building systems, but also in their layout and organization. The nature and activities of today's scientific research and support have outgrown many of the facilities in which they now occur. For the Master Plan, the team reviewed each campus building for its condition and functional suitability. Additionally, they interviewed the building managers and users to identify current and anticipated issues. Following is a summary of key observations and issues.

- **Environmental Control.** Much of the advanced research taking place on the Boulder campus is based on precise performance and measurements, which demand very controlled environments—rigorous temperature and humidity control, vibration stability, air cleanliness and quality electric power. Other than in Buildings 81 and 33, these conditions are difficult to achieve. Researchers make due in the older lab buildings, but time is wasted and experiments sidelined. Renovations to several wings of Building 1 are expected to meet the requirements of the laboratories.
- **Separation of Working Groups.** Functional units and research working groups are not located together, with related laboratories and/or offices located in several buildings. This situation was magnified when the Gebbie Laboratory opened and the most environmentally demanding labs were relocated. Collaboration on projects, sharing of resources and working efficiency are compromised.
- **Scattered Administration.** Like the scientific groups, the administrative functions are scattered across the campus, and housed in a variety of small and modular buildings. Construction, facility management, maintenance, administration, and contracting/acquisition personnel are all located in separate buildings (7 in all). Not only are opportunities for human synergy lost, but multiple buildings use more energy, and necessitate the duplication of resources and equipment.

- **Front Door.** There is no recognizable *front door* or *downtown* for visitors and staff. The head-house of Building 1 was once the main campus entry, but with the relocation of the entry road, each building seems autonomous, and the entrance nearest its parking lot becomes the main one. What is lost in this scenario is a sense of place and a central location where staff casually meet or come together across various organizations.

- **Lack of Amenities.** Spaces that draw people together or provide general support are limited, constrained by space pressure or circumstance. No food service or coffee bar facilities are available in the NIST Buildings; there is a cafeteria in the NOAA building, open to all on campus but not as convenient for the NIST community. Although there are some break rooms, coffee pots and small refrigerators appear in many office areas, which is against DoC policy. Former collaboration space and small meeting rooms have become offices and lab support areas, as space is needed.



- **Conference Conundrum.** NIST and NOAA host a number of conferences on campus. The NIST auditorium serves as a campus-wide resource, equipped with up-to-date video and telcom technology. But there are other desired conferences not held on campus because of space, security and service concerns. Conference space is available in three buildings—Buildings 1, 81 and 33—but they are not located near enough to support each other for larger conferences. Security also constrains certain conferences. Each attendee must go through security badging and vehicle screening, with extra hurdles if the attendee is not a US citizen. Food services are not readily available at the DoC campus, and each conference must be catered for coffee or meals. If not catered, attendees leave the campus for meals. Sometimes the conference hosts arrange for attendees to park at an off-site hotel and be brought in by bus to expedite the security screening.

- **Wayfinding.** Wayfinding can be a challenge, because of both limited signage and confusing layouts. The Radio Building (Building 1) steps up the slope, so that the floors of the central spine are discontinuous, and vertical transitions must be made to reach all the wings; there is only one elevator and 2 stairs that reach all levels. Within some older buildings, renovations and additions have created multiple corridors and confusing circulation. Visitors are typically escorted, following security policy but also ensuring they can find their desired location.

- **Changing Role of Library and Media.** Library facilities exist in both NIST and NOAA facilities, with the NIST Building 1 library considered the main library and NOAA the branch. Journals and other resources are more and more available on-line, from the researcher's desktop; librarians are changing their role to direct information research and encourage shared resources/collaboration. In parallel, the NOAA Information Technology group wants to offer education and collaborative software research into new technologies that will aid in the science. Together, there is the potential for synergy, and a reconsideration of the "library."

- **Duplication of Resources**. Multiple buildings with multiple working groups suggest a review of support facilities, to improve their quality and utilization. One example is the number of staff workshops on campus. The main machine shop creates tools and parts on a per-order basis, but other workshops are available to staff for immediate and minor work. There are at least eight of them within the NIST lab buildings, created by different groups and unsupervised.

- **Storage.** Active equipment and temporarily side-lined equipment are hard to distinguish, but the planning team was told that there is limited designated storage space. Items are stored within lab areas, limiting the flexibility of the labs. The campus has approached the storage issue by adding shipping containers placed on the site, many of them in and around Building 21 and its adjacent yard. On campus, the current count is 43 containers, or approximately 11,000 SF of storage space. Note, the containers are referred to as Conexes, after Container Express, a logistical container loading method.

- **Temporary Buildings.** Incremental growth on campus has been addressed by adding modular buildings, small buildings and additions—resulting in the separation of working groups mentioned above, in physical and energy-related inefficiencies and an unorganized campus. In all, there are 10 modular buildings on campus, together with another 10 small buildings, each less than 4,000 square feet.

13.2 Visual Character

The initial campus development in the 1950s presented a strong community image and campus organization, with the NIST (then NBS) public face and entrance directly at the intersection of 27th Way and Broadway. Vehicles entered the campus at 27th Way with the visual impact of the Radio Building's front façade and main entrance. Subsequent development and the shift of the campus entrance have diluted that image. Now, the drive into campus is dominated by the NOAA building on the left, and multiple buildings/wings on the right. The current entry drive and parking no longer allow appreciation of the Radio Building's front appearance. The campus has no apparent organizing principle or unifying elements, either building vocabulary, circulation or landscape treatment. The Flatirons provide a dramatic backdrop, and do enhance the visual impression of the campus.

Pressing needs, coupled with procurement realities, have been addressed in recent years with small additions and modular buildings. Each is undistinguished in design, and together they give the campus a haphazard and temporary appearance. This is made worse by the random parking of construction trailers and use of multiple shipping containers for storage at the western side of the property.

The major buildings—Katharine Blodgett Gebbie Laboratory and David Skaggs Research Center and the renovated wings of the Radio Building 1—are well-designed, attractive buildings that project an image appropriate to the advanced research taking place.

NIST Boulder

Exhibit 124: Summary of Campus Buildings

Building Number and Name	Size (GSF)	Year Completed	Occupants	Spaces
1 Radio Building (Wings 1–6 + Spine)	336,909 1–5 story	1954	Various Labs and Admin.	Labs, Offices; Public; Support
1C Annex	4,611 1 story	1989	PML	Offices (research)
1D Annex	3,456 1 story	1992	PML	Offices (research)
1E Annex	Equipment Structure	Not available	–	Mechanical Equipment
1F Annex	Equipment Structure	Not available	–	Mechanical Equipment
2 Cryogenic	69,771 3 story	1951	PML; MML	Labs; Offices (research)
2A Cryogenic Annex	2,880 1 story	1989	PML	Labs; Offices (research)
3 Liquifier	17,403 1 story	1952	MML; Mgmt. Resources.	Labs; Support
3A OFPM Annex	2,160 1 story	1989	OFPM	Offices (admin)
4 Camco	15,795 1 story	1951	OFPM	Offices (admin)
5 Camco Annex	3,149 1 story	1951	OFPM; CTL	Offices (admin); Lab
8 Cryogenic Mesa Test	2,400 1 story	1953	MML	Labs
9 Gas Meter Building	Equipment Structure	1958	–	Water Pump Equipment
11 Ionospheric Obser.	466 1 story	1958	NOAA	Labs
12 Hydrogen Test Facility	1,446 1 story	2010	MML	Lab, Support
21 Maintenance Garage	3,999 1 story	1963	OFPM	Support; Offices (admin/ support)
22 Warehouse	17,530 1 story	1964	NOAA	Support (Shipping and Receiving, Warehouse)
23 Hazardous Materials	984 1 story	1989	Safety, Health & Environ.	Support
23A Hazard. Materials Annex	Equipment Structure	1989	–	Mechanical Equipment
24 Plasma Physics	32,723 3 story	1967	CTL; PML	Labs; Offices (research)
25 Maintenance Shop	8,306 1 story	1966	OFPM	Support (workshops); Offices (support)
25 MI Building 25 Annex	525 1 story		OFPM	Offices Support
26 Childcare Center	7,776 1 story	1989	OFPM manages	Support/Public (Classrooms)
27 High Frequency Field	1,045 1 story	1992	CTL	Lab (Antenna testing w/ RF Shielding)
41 High Speed Switch	Equipment Structure	Not available	–	Electrical Equipment
42 Central Utility Plant	45,845 3 story	2005	OFPM	Support (Utility); Offices (support)
51 Security Center	1,470 1 story	2006	Police	Support (Visitor Screening)
81 Katharine Blodgett Gebbie Laboratory	286,674 1 story	2012	PML; CTL; MML	Labs; Offices (research); Public (conference center)
91 Construction Research	3,561 1 story	2008	OFPM	Offices (admin)
111 Building 4 Annex	2,821 1 story	2011	Acquisition Mgmt. D	Offices (admin)
112 Butler Building	5,795 1 story	2011	Facilities & Property Mgmt.	Support (storage)
131 Office	1,440 1 story	2013	OFPM	Offices (admin)
– Concourse	1,234 1 story	2012	–	Connector–Buildings 1 and 81
NIST Total	**882,174**			
33 David Skaggs Research Center	372,000* 4 story	1999	NOAA	Labs; Offices; Public (Cafeteria, Multi-purpose, Display, Fitness)
34 NOAA Solar Observatory	incl. above 1 story	1999	NOAA	Lab
Site Total	**1,254,174**			

*NOAA now reports 415.973 GSF as existing, because of changed measurement methodology: see Program section.

Existing Building Examples

Building 81: Katharine Blodgett Gebbie Laboratory

Building 33: David Skaggs Research Center

Building 3: Liquifier Building

Building 1D: Annex

Building 2A: Cryogenic Annex

NIST Boulder

Building 1: Radio Building

Buildings 4 and 5: Camco

Building 22: Warehouse

Building 26: Childcare Center

Building 91: Construction Research

14 Cultural Resources

THE National Institute of Standards and Technology, Boulder, Colorado identifies, evaluates, and manages historic properties under its stewardship in accordance with Section 106 and Section 110 of the National Historic Preservation Act of 1966, as amended (NHPA). Historic properties are cultural resources, i.e. buildings, structures, objects, sites, or districts that are listed in, or eligible for listing in the National Register of Historic Places (NRHP). Major studies completed to support cultural resources compliance efforts include the *Historic Assessment, National Institute of Standards and Technology, Boulder, Colorado* (R. Christopher Goodwin & Associates, Inc. 2016) and the *Results of an Intensive Cultural Resources Inventory of the Boulder* NIST *Site, Boulder, Colorado* (Larson-Tibesar Associates, Inc. and Gulf Engineers and Consultants, 1994). In addition, agreements have been executed related to the management of historic properties and sacred sites.

14.1 National Register of Historic Places Criteria

Properties are evaluated for significance and integrity by applying the NRHP Criteria for Evaluation found in 36 CFR 60.4 (a-d). To be listed, or considered eligible for listing, in the NRHP, a property must meet at least one of the four following criteria:

- **Criterion A**: The resource is associated with events that have made a significant contribution to the broad pattern of history.
- **Criterion B**: The resource is associated with the lives of people significant in the past.
- **Criterion C**: The resource embodies distinctive characteristics of a type, period, or method of construction; represents the work of a master; possesses high artistic value; or represents a significant and distinguishable entity whose components may lack individual distinction.
- **Criterion D**: The resource has yielded, or may be likely to yield, information important in prehistory or history.

In addition, the National Register has established Criteria Considerations applicable to cemeteries, properties owned by religious institutions, reconstructed or moved structures and other specialized situations. These may be eligible if they are integral to districts that meet the criteria, or if they fall within specifically defined categories.

The National Register also defines seven aspects of integrity to determine if a resource retains the ability to convey significance: location, design, setting, materials, workmanship, feeling, and association (U.S. Department of Interior 1997:44). Not all seven aspects are required for eligibility, but the property must retain the integrity necessary to convey its significance. Resources must possess overall historical integrity as well as significance to qualify for NRHP eligibility.

14.2 Summary of 2016 Assessment Findings

The majority of buildings at the Boulder campus are less than 50 years old, and were constructed between 1989 and 2013. None of the more recent buildings appear to satisfy Criterion Consideration G for exceptional significance. Buildings at the DoC Boulder Campus that are 50 years old or older include:

- **Building 1, (Radio Building)**: In a 2016 letter[30], the Colorado State Historic Preservation Officer (SHPO) rec-

30 Steve Turner, SHPO, to Virginia Holtzman-Bell, Boulder Laboratories Site Manager; February 23, 2016, Boulder Colorado

ommended Building 1 as eligible for listing in the NRHP under Criteria A and possibly C. Follow-up discussions have confirmed that recommendation. NIST and the SHPO are in consultation to negotiate protocols that will govern future renovation in accordance with 36 CFR Part 800 – Protection of Historic Properties and the Secretary of the Interior's *Standards for the Treatment of Historic Properties*.

- **Building 2 (Cryogenic Building); Building 3 (Liquifier Building); Building 4/5 (Camco)**: Buildings 2, 3, and 4/5 previously were recommended as potentially eligible for listing in the NRHP. On September 9, 2015 correspondence[31] with the Colorado State Historic Preservation Officer (SHPO) clarified that, because of a lack of integrity, Building 3 no longer is NRHP eligible. Because Building 3 is not eligible, the two other buildings (Building 2 and 4) associated with Building 3 also are not NRHP eligible.
- **Anderson Ditch**: Anderson Ditch has been determined eligible for listing in the National Register, with a potential for significance under Criteria A, B, and C. Note that Anderson Ditch is privately owned, with an easement through government property.
- **Building 8 (Cryogenic Mesa Test); Building 9 (Gas Meter Building); Building 11 (Ionospheric Observatory); Building 21 (Maintenance Garage); Building 22 (Warehouse); and Building 24 (Plasma Physics)**: These six buildings do not appear to be NRHP eligible.

14.3 Archeological Resources

The 1994 cultural resources investigation completed by Larson-Tiberar Associates, Inc. did not identify any prehistoric archeological resources.

14.4 Agreement Documents

- A Programmatic Agreement (PA) *Regarding Protected Areas at the Department of Commerce Site, 325 Broadway, Boulder, Colorado* was executed in 1995 among NIST, the City of Boulder, eleven Native American tribes, and the Medicine Wheel Coalition for Sacred Sites in North America. The stipulations of the PA address maintenance, utility work, and tribal use within a 24.95 acre Tribal easement area.
- The Department of Commerce updated an easement agreement in 2007 with the Anderson Ditch Company for access through the campus, rights for irrigation use and NIST repair and maintenance of the section of the Ditch on DOC property.

14.5 Significance for the Master Plan

Under 36 CFR 800, when a Federal agency plans an undertaking, the agency is required to take into consideration the effects it will have on historic properties, and afford the Advisory Council on Historic Preservation the opportunity to comment. An undertaking is any project, including projects requiring a Federal license, permit, or approval, funded directly or indirectly by a Federal agency.

The SHPO is a consulting party under 36 CFR 800, and the Office of Archaeology and Historic Preservation functions as the SHPO in Colorado. Their determination that Building 1 is NRHP eligible means that changes to the building will require submission to the SHPO, under Section 106 of the NHPA. The Colorado SHPO recommended that Building 1 renovation projects be approached as "Rehabilitation," one of the four treatment methods prescribed by the Secretary of the Interior Standards.

31 Edward C. Nichols, SHPO, to Virginia Holtzman-Bell, Boulder Laboratories Site Manager; September 9, 2015, Boulder Colorado

Exhibit 125: Building Construction History

1954 Photograph of Building 1

Image courtesy of NIST Boulder

1967 Photograph of Building 3, looking west

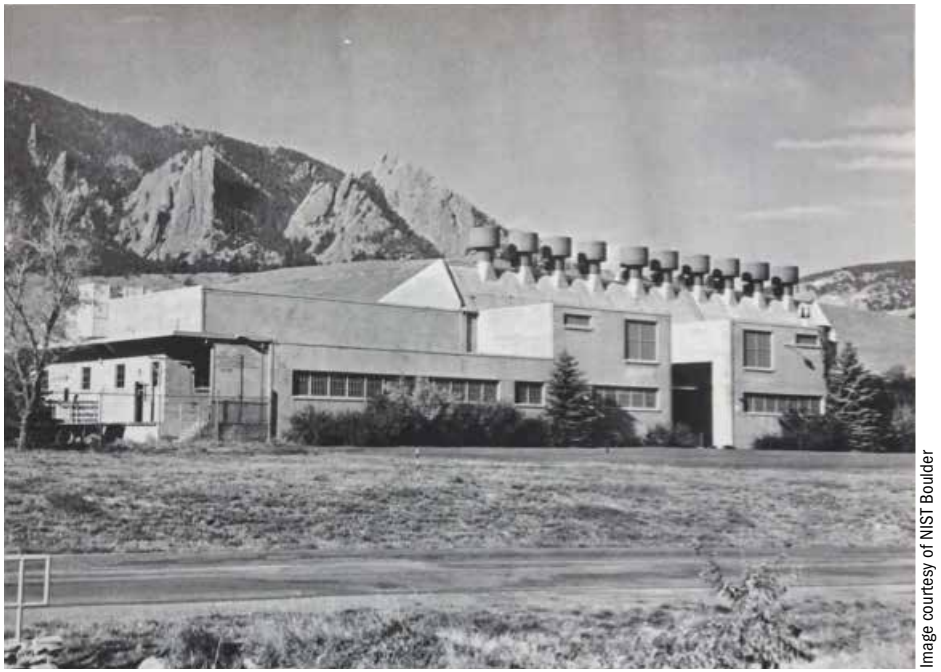


Image courtesy of NIST Boulder

1964 Photograph of Building 2, Wing B

Image courtesy of NIST Boulder

1967 Photograph of Building 4, looking southwest

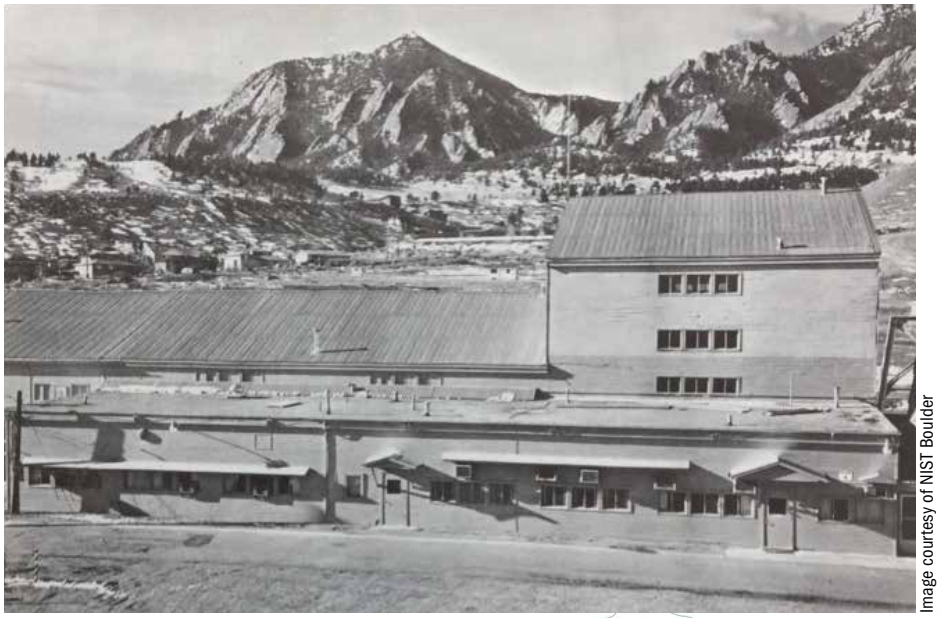


Image courtesy of NIST Boulder

15 Circulation and Transportation

15.1 Overview

The Department of Commerce Campus in Boulder is located on Broadway (State Highway 93), a major arterial road in the City of Boulder, between Baseline Road and Table Mesa Drive. Broadway, a six-lane urban roadway, has a raised median and left-turn-lanes at side street intersections. The posted speed limit is 40 mph. The intersection with Rayleigh Road is a signalized intersection with a northbound left-turn protected/permitted signal phase.

There is a second curb-cut into the site from Broadway across from 27th Way. This access does not serve any of the DoC facilities; it provides the only means of access to a parcel to the north, which currently has a medical office building. The intersection of 27th Way and Broadway is not signalized.

The Campus also has two additional gated access points, one to the north from King Avenue, and the other from Dartmouth Avenue, both residential streets. These gated access points are closed to general motorized traffic.

15.2 Internal Vehicular Circulation

The primary access to the site from Broadway is through Rayleigh Road. Visitors and deliveries to the campus are required to go through a screening process at the Visitor Center and Vehicle Inspection Facility located off of Rayleigh Road. There is a checkpoint on Rayleigh Road to check employee and visitor credentials.

Majority of the NIST buildings in the campus are within two loops, both accessible from Rayleigh Road. The major laboratory buildings—Buildings 1, 2, and 81—are located north of the campus bounded by a loop formed by Compton Road and Marconi Road and Wilson Road. The major facility buildings and Building 3 are bounded by the second loop formed by Curie Circle and Compton Road. NOAA's primary facility, Building 33, is to the south of Rayleigh Road; and the Solar Observatory, Building 34 is situated on Compton Road just south of the Spine Road (a continuation of Rayleigh Road).

The facilities west of Skunk Creek are served by Kusch Road and the NIST Service Road (a continuation of Kusch Road).

15.3 Pedestrian and Bicycle Paths

The City of Boulder's multi-use path runs along the Broadway frontage of the campus which carries significant bicycle traffic. Within the campus, there is a designated bike path along most of the primary vehicular circulation routes. A segment of the City's multi-use path, called Skunk Canyon Path runs along Skunk Creek connecting the campus bike path to the neighborhoods south of the campus circulation routes.

Segments of soft surface hiking trails also pass through the non-research zones of the campus. In addition there is a robust network of pedestrian pathways connecting the campus buildings.

15.4 Public Transit and Bike Share

There are two bus stops located on the Broadway frontage of the DoC campus—one near the north east corner of the campus at 27th Way and Broadway; and the other south of the Rayleigh Road entrance at Ash Avenue and Broadway. These stops, both of which have shelters, exist in accordance with a revocable 5-year agreement between DoC and Regional Transportation District (RTD). As of this writing, BOUND and AB bus lines use the bus stop at 27th Way, and buses between

Exhibit 126: Current Campus Circulation

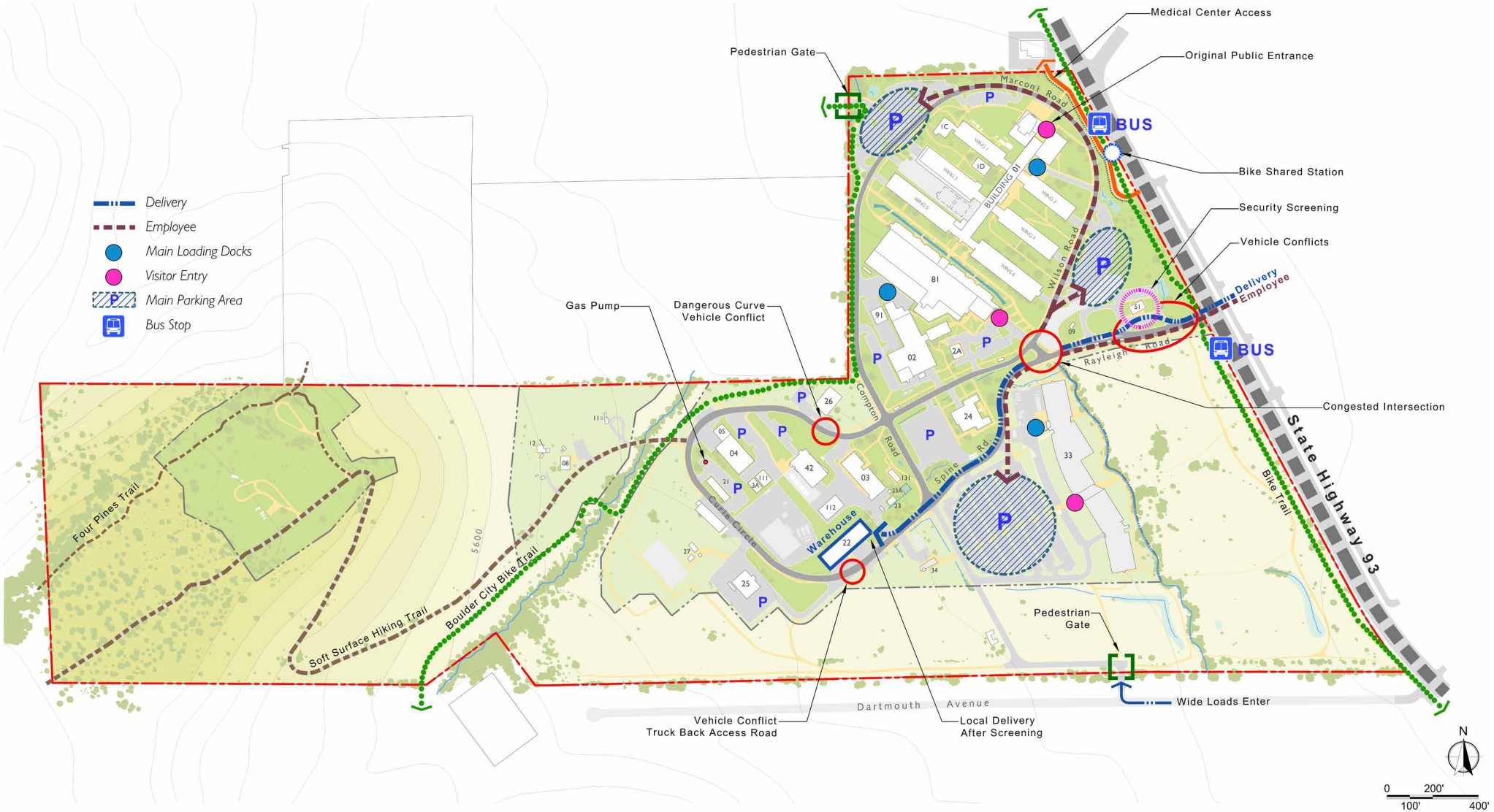
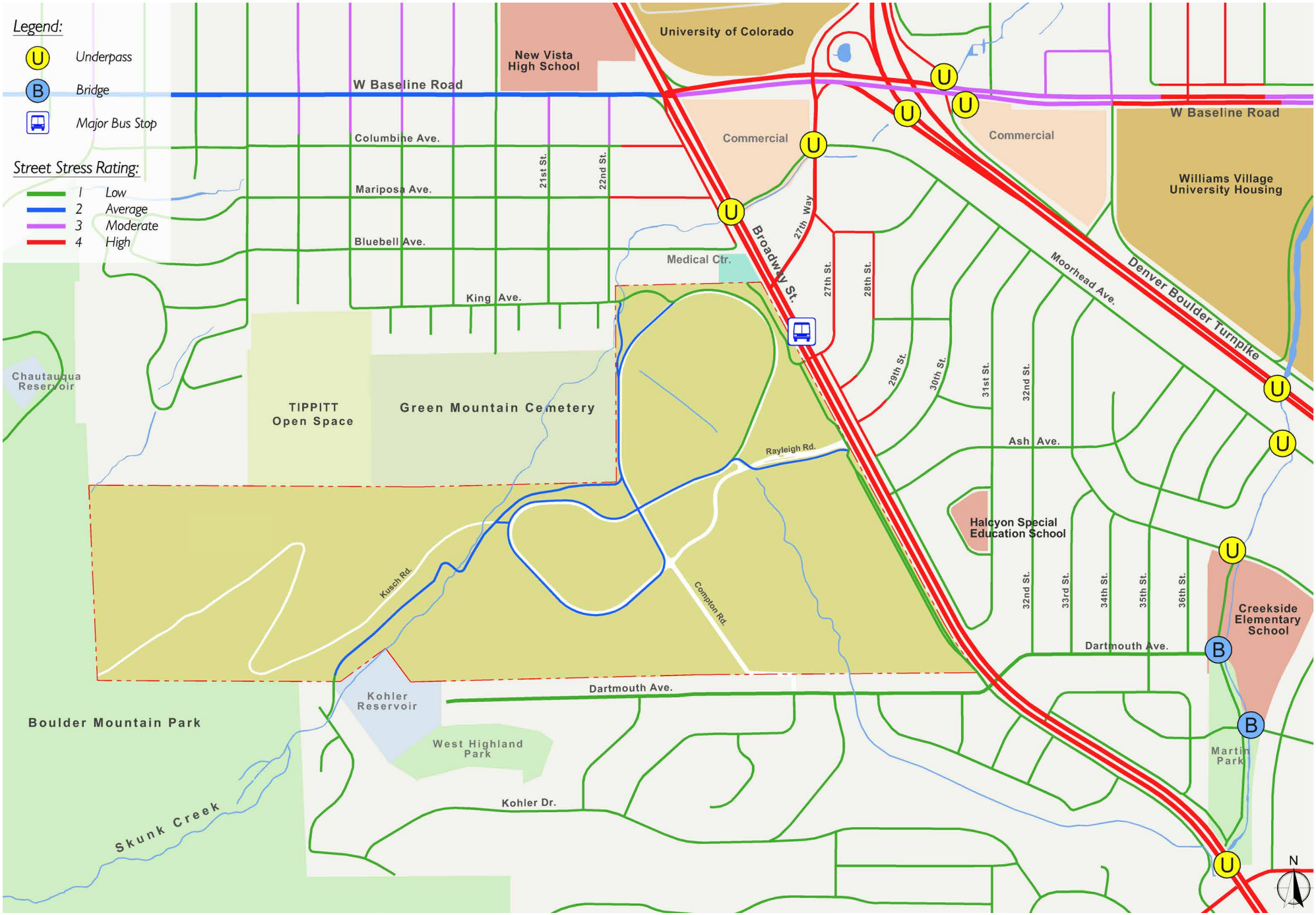


Exhibit 127: Pedestrian and Bicycle Facilities Near the Campus



Denver and Boulder use the bus stop at Rayleigh Road.

There are two Park-n-Ride locations proximate to the campus at 27th Way and Broadway and at 32nd Street and Broadway.

15.5 Parking

The Campus has 1,430 parking spaces across 18 surface parking lots. About 52 of these parking spaces are accessible to persons with disabilities. The largest of these lots serves the two NOAA buildings, Building 33 and Building 34 and has 600 parking spaces. The largest parking lots serving the NIST buildings are located northwest and southeast of Building 1, with 192 and 160 parking spaces respectively.

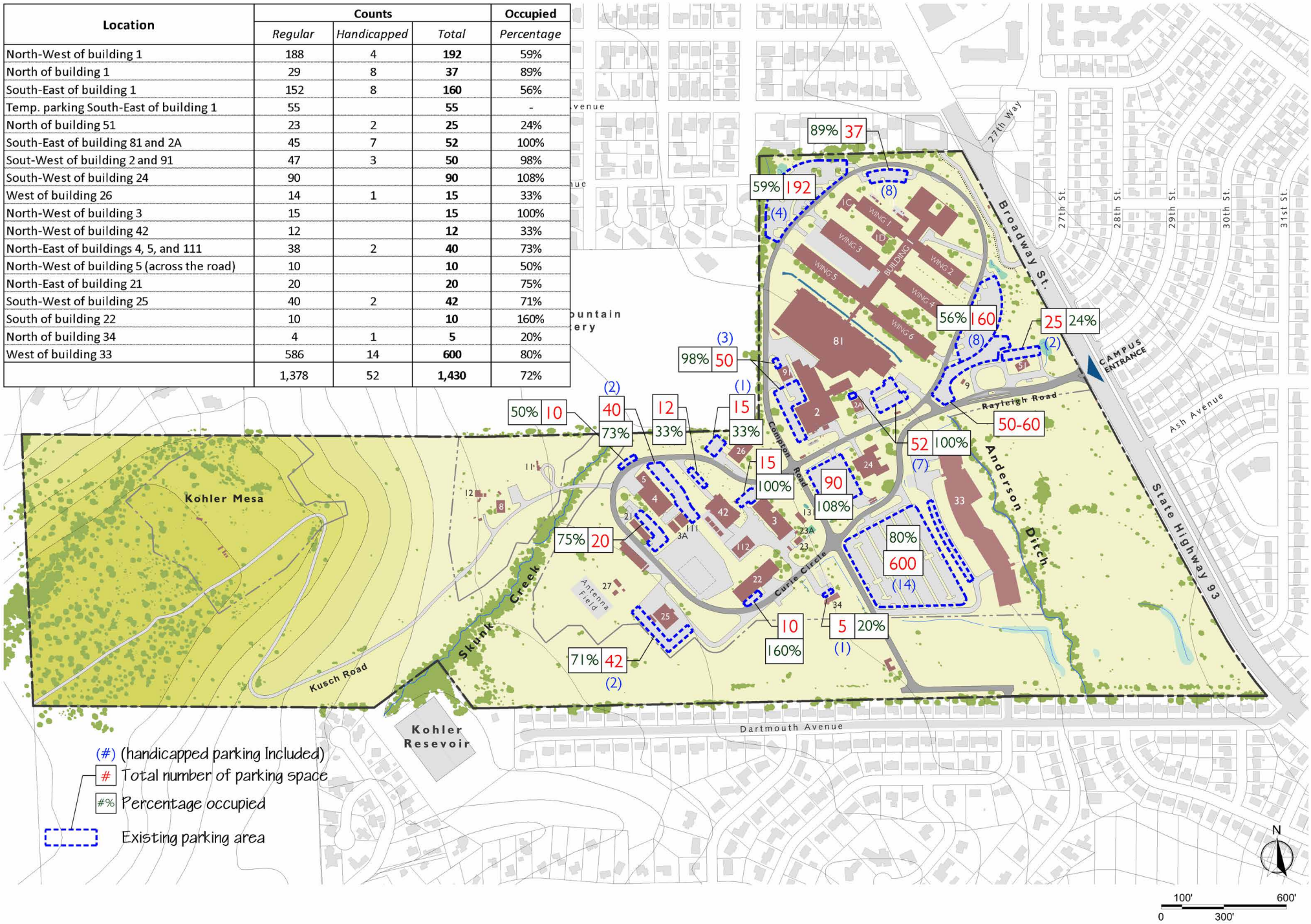
A parking usage survey was carried out for the campus. The campus was generally divided into five functional parking zones (the security center and the 4 quadrants noted in the table). The Security Center was separated from the quadrants since it functions differently. In reality, the existing 25 parking spaces are enough to serve the Security Center, however the current layout is inefficient. The overall occupancy rate for the campus based on the survey is about 73%. A ratio of observed occupied spaces per employee (about 0.59) was calculated to estimate parking demand.

Exhibit 128. Summary of Parking Survey

	Existing				
	Employees	Spaces	Occupancy	Occupied Spaces	Occupied Spaces/ Employee
Security/Visitor	**4**	**25**	**0.24**	**6**	**1.50**
Next to of Building 51		25	0.24	6	
Quadrant 1	**393**	**444**	**0.53**	**236**	**0.60**
North of Building 1		37	0.89	33	
Northwest of Building 1		192	0.59	113	
Southeast of Building 1		160	0.56	90	
Temporary parking SE of Building 1		55	–	–	
Quadrant 2	**290**	**222**	**0.98**	**218**	**0.75**
New Garage		–	–	–	
2A and Southeast of Building 81		52	1.00	52	
Southwest of Buildings 2 and 91		50	0.98	49	
Southwest of Building 24		90	1.08	97	
West of Building 26		15	0.33	5	
Northwest of Building 3		15	1.00	15	
Quadrant 3	**126**	**134**	**0.74**	**99**	**0.79**
Northwest of Building 42		12	0.33	4	
Northeast of Buildings 4, 5, and 111		40	0.73	29	
Northwest of Building 5		10	0.50	5	
Northeast of Building 21		20	0.75	15	
Southwest of Building 25		42	0.71	30	
South of Building 22		10	1.60	16	
Quadrant 4	**948**	**605**	**0.80**	**481**	**0.51**
North of Building 34		5	0.20	1	
West of Building 33		600	0.80	480	
Total	**1,761**	**1,430**	**0.73**	**1,040**	**0.59**

Exhibit 129: Current Campus Parking Distribution

Location	Counts			Occupied
	Regular	*Handicapped*	*Total*	*Percentage*
North-West of building 1	188	4	**192**	59%
North of building 1	29	8	**37**	89%
South-East of building 1	152	8	**160**	56%
Temp. parking South-East of building 1	55		**55**	-
North of building 51	23	2	**25**	24%
South-East of building 81 and 2A	45	7	**52**	100%
Sout-West of building 2 and 91	47	3	**50**	98%
South-West of building 24	90		**90**	108%
West of building 26	14	1	**15**	33%
North-West of building 3	15		**15**	100%
North-West of building 42	12		**12**	33%
North-East of buildings 4, 5, and 111	38	2	**40**	73%
North-West of building 5 (across the road)	10		**10**	50%
North-East of building 21	20		**20**	75%
South-West of building 25	40	2	**42**	71%
South of building 22	10		**10**	160%
North of building 34	4	1	**5**	20%
West of building 33	586	14	**600**	80%
	1,378	52	**1,430**	72%



(#) (handicapped parking Included)
Total number of parking space
#% Percentage occupied
Existing parking area

15.6 Vehicular Turning Maneuver Data Collection Summary

Vehicle circulation data collection and observation were undertaken on a typical spring day at the DoC campus in Boulder, Colorado. This data collection effort is the first step in a more extensive master planning exercise, and will be used as a basis for further analysis as the master planning is further developed.

Vehicular and bicycle turning maneuver as well as pedestrian crossing data was collected on Wednesday, April 29, 2015 from 6:30 AM to 9:30 AM and from 3:30 PM to 6:30 PM to determine the peak hour utilization of several intersections on and surrounding the DoC campus. Data was collected when local schools, as well as the nearby University of Colorado, were in session. In addition, observations were made regarding queuing and other general traffic flow conditions at the study intersections.

Vehicular access to the campus is provided via a single entrance from Broadway at Rayleigh Road on the eastern side of the campus. Pedestrian and bicycle access is provided via entrances from Broadway to the east near 27th Way and at Rayleigh Road, from Dartmouth Avenue to the south via Compton Road, and from King Avenue to the north via Compton Road. An extensive bicycle and pedestrian network surrounds the campus, connecting it to various local destinations such as the University of Colorado, Downtown Boulder, and many of the surrounding parks and neighborhoods.

The following lists the eight off-campus intersections and four on-campus intersections where data was collected:

Off-Campus Intersections	On-Campus Intersections
1. 27th Way/Baseline Road	1. Rayleigh Road/Lawrence Road-Wilson Road Connector
2. Broadway/Baseline Road	2. Lawrence Road/Wilson Road/Rayleigh Road Connector
3. Broadway/27th Way	3. Rayleigh Road/Curie Circle/Compton Road
4. Broadway/Rayleigh Road	4. Lawrence Road/Curie Circle/Compton Road
5. Broadway/Dartmouth Avenue	
6. Broadway/Table Mesa Drive	
7. Kenwood Drive/Compton Road/Dartmouth Avenue	
8. 22nd Street/King Avenue	

The peak hours were determined to be from 7:45 AM to 8:45 AM and from 5:00 PM to 6:00 PM for the off-campus intersections and from 8:00 AM to 9:00 AM and from 5:00 to 6:00 PM for the on-campus intersections. The off-campus vehicular turning maneuver data is summarized in Exhibit 130 and the on-campus vehicular turning maneuver data is summarized in Exhibit 131.

The vehicular turning maneuver data summarized above was also utilized to estimate 24-hour Average Daily Traffic (ADT) volumes for each of the study roadways, as summarized on Exhibit 132. Based on the vehicular counts, the 24-hour ADT volumes were estimated as noted below:

- Broadway, Table Mesa Drive, Baseline Road east of Broadway, and 27th Way just south of Baseline Road were all estimated to have ADTs of well over 15,000 vehicles per day.
- Baseline Road west of Broadway and 27th Way just east of Broadway were both estimated to have ADTs of between 10,000 and 15,000 vehicles per day.
- The US Route 36 Off-Ramps to Baseline Road and 27th Way were estimated to have an ADT of 5,000 to 10,000 vehicles per day.
- Dartmouth Avenue west of Broadway, Kenwood Drive, and Rayleigh Road from Broadway through its connector intersection with Lawrence Road and Wilson Road were all estimated to have ADTs of 1,000 to 5,000 vehicles per day.
- Dartmouth Avenue east of Broadway, 22nd Street, King Avenue, Wilson Road, Lawrence Road, Curie Circle, Compton Road, and Rayleigh Road just east of Compton Road were all estimated to have ADTs of less than 1,000 vehicles per day.

Vehicular traffic observations noted some congestion along Broadway, Baseline Road, and Table Mesa Drive during the peak hours throughout the study area; however queues were noted to clear with most traffic signal cycles. Some queuing was noted for employees entering the DoC campus along Rayleigh Road, but this queuing did not extend to Broadway. While most visitors to the site heeded signage for vehicular inspection and check-in, some visiting vehicles were noted to be rejected by security and sent back to the vehicle inspection location adjacent to the Visitors Center. Very little congestion was noted on campus.

Exhibit 130: Peak Hour Traffic Volumes in Off-Campus Intersections

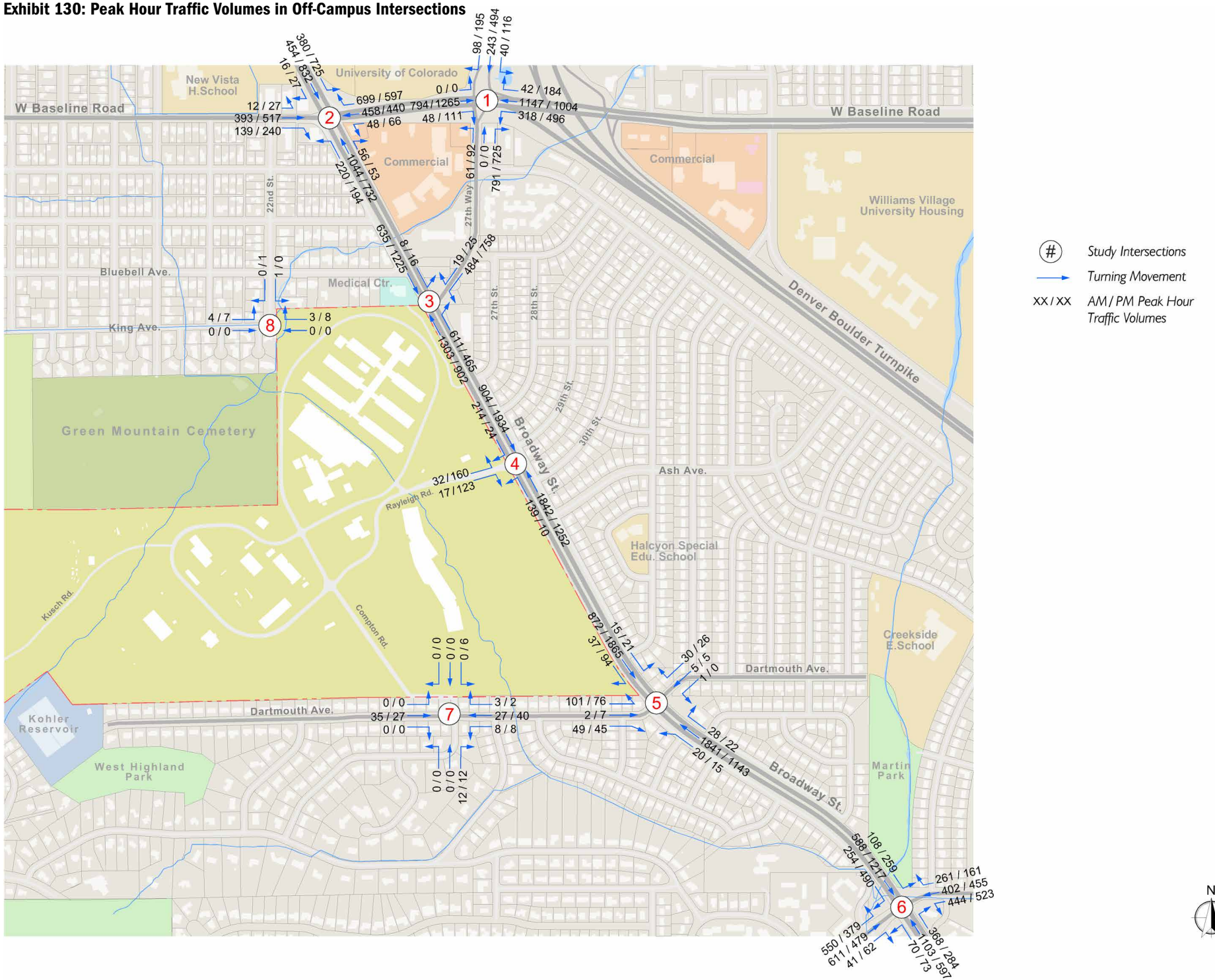
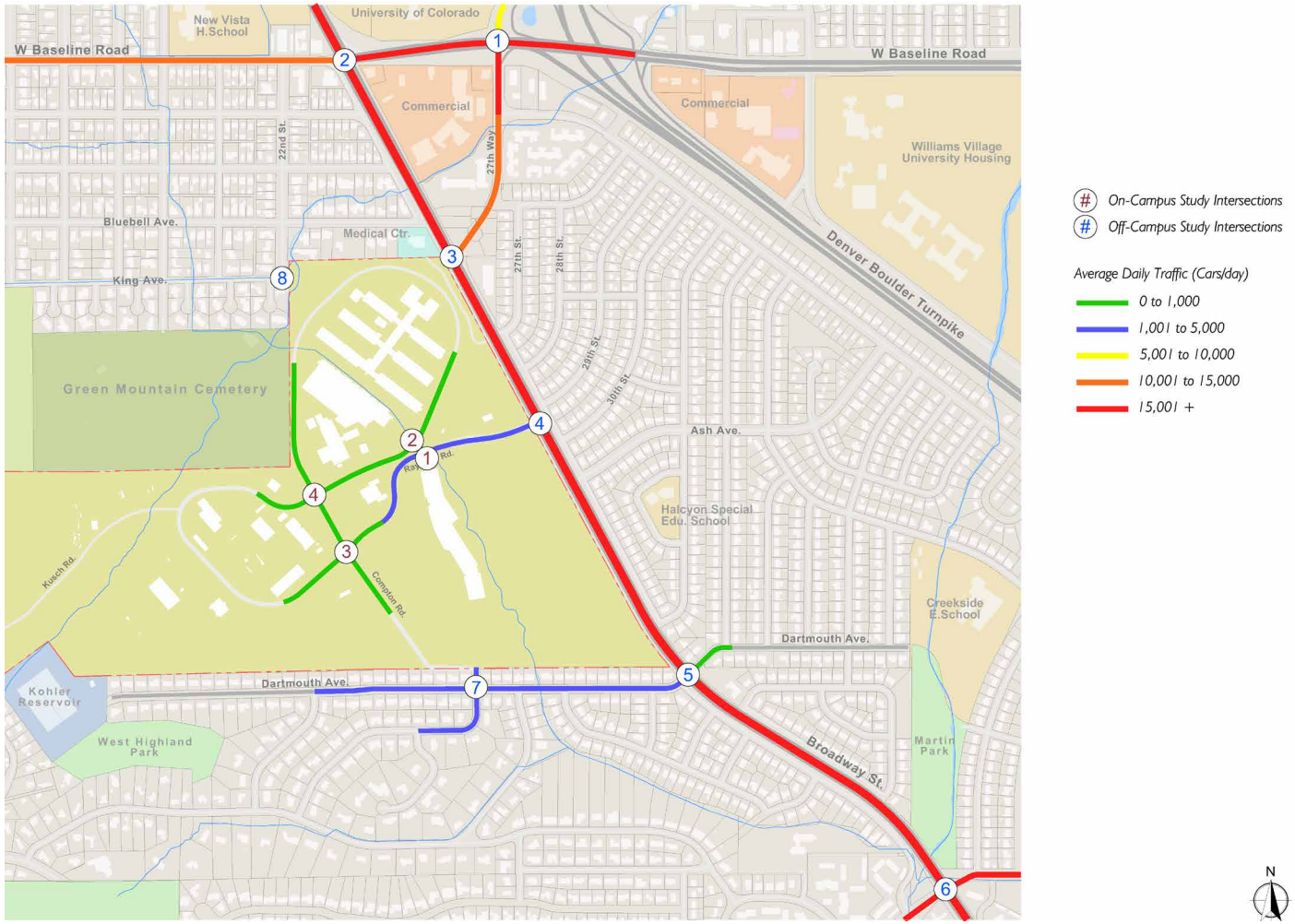


Exhibit 131: Peak Hour Traffic Volumes in Campus Intersections

Exhibit 132: Estimated Average Daily Traffic (ADT) Volumes



15.7 Bicycle Turning Maneuver Collection Summary

As with the vehicular turning maneuver data, bicycle turning maneuver data was collected at all of the study intersections on Wednesday, April 29, 2015 from 6:30 AM to 9:30 AM and from 3:30 PM to 6:30 PM as well. These volumes are summarized below in Exhibits 133 and 134. Observations noted that most off-campus cyclist utilize the extensive bicycle pathway system in place surrounding the campus. Some bicyclists were noted passing through campus, primarily using Compton Road to travel north-south across the campus (as noted in the bicycle counts on Exhibit 9). While data was not collected as a part of the scope of this effort, significant usage of the bicycle path immediately adjacent to the entrance of the DoC campus and parallel to Broadway was noted for cyclists commuting into and out of Boulder, to the north of the campus.

Exhibit 133: Bicycle Volumes for Off-Campus Intersections

Exhibit 134: Bicycle Volumes for On-Campus Intersections

Exhibit 135: Pedestrian Volumes for Off-Campus Intersections

Exhibit 136: Pedestrian Volumes for On-Campus Intersections

15.8 Pedestrian Crossing Data Collection Summary

As with the vehicular and bicycle turning maneuver data, pedestrian crossing data was collected at all of the study intersections on Wednesday, April 29, 2015 from 6:30 AM to 9:30 AM and from 3:30 PM to 6:30 PM as well. These volumes are summarized below in Exhibits 135 and 136. Observations noted some pedestrian activity on-campus, but most pedestrian activity was concentrated north of the DoC campus and closer to the University of Colorado.

Another measure of high pedestrian traffic within the campus is the perimeter door usage for the buildings. These numbers, for a typical weekday, were obtained from NIST and plotted on a campus plan.

Exhibit 137: Door Usage

Metropolitan Architects & Planners, Inc.
Alexandria, VA

Affiliated Engineers
Washington DC

Eastern Research Group, Inc.
Chantilly, VA

Gorove/Slade
Washington, DC

R. Christopher Goodwin & Associates, Inc.
Frederick, MD

Rhodeside & Harwell
Alexandria, VA

RMF Engineering
Baltimore, MD