In This Issue:

Laboratory Design ........... 3
Global Health .................. 8
Infectious Disease Programs ... 9
Emergency Preparedness ...... 12
Fellowships .......... 14
NLTN .......................... 15
Newborn Screening .......... 16
Environmental Health ...... 18
APHL Annual Meeting ...... 20
Member News: Kansas ..... 22
Lab Oratory ................. 24
Member News: Corpus Christi . 25
Staff News ................. 28

As Labs Age, States Must Decide: Make Do or Modernize? (page 3)
As Labs Age, States Must Decide: Make Do or Modernize?

“Form follows function—that has been misunderstood. Form and function should be one, joined in a spiritual union.”

Frank Lloyd Wright

When Mary Gilchrist, director of Iowa’s public health laboratory, takes guests through her facility, she prefers to show them high science. Instead, for the past few years she has treated state legislators and other visitors to what she calls “the crumbling infrastructure tour.”

The building housing the Iowa lab dates to 1917 and is probably the oldest public health laboratory structure in active use today. Originally constructed as a tuberculosis sanatorium, the building features numerous, tiny patient rooms strung out along long narrow corridors. It was never well-suited for laboratory work.

Now in its 89th year, the building is downright hazardous. Ceilings are too short to accommodate biosafety cabinets. Water pipes are corroding. The presence of asbestos in every wall precludes easy renovation or even easy access to the plumbing and electrical infrastructure for maintenance. “We’ve had to be really smart,” said Gilchrist.

Despite the best efforts of the laboratory staff, efficiency has suffered. Not being able to tear down walls, for example, was a hindrance when the laboratory had to gear up for West Nile virus testing a few years back. Multitasking is a challenge. “While lab tests are running,” said Gilchrist, “people can’t go to do other work or to help their neighbors because everything is spaced out so much.”

Luckily for Iowa’s staff—and its residents—the Iowa legislature was willing to invest in a modern public health laboratory facility.

A Brave New World for Some Labs

Iowa is one of at least 19 states—ranging from Alaska to Arkansas—that has either already built updated public health laboratories or are poised to do so. Warren Hendrickson, a principal with the laboratory design firm CUH2A, has been involved in many of these projects and has witnessed the before-to-after transformations.

“The (older public health laboratory) buildings that we’ve seen,” he said, “have been really awful. (Public health laboratorians) have been living in a make-do environment. We want the building to be a partner in their science and to give them a can-do attitude. When you walk through their labs and see how well they’ve done with so little, you can only imagine how well they’d do if they were empowered to have the building work with them.”

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“I now can select the instrument we really want because we have the space for it. Before we had to see the physical footprint of the instrument. Can I fit it in? versus Is this the best instrument for the work we want to do?”

No longer do scientists have to bring in extra power lines for high-voltage instruments, contend with water cascading down stairwells from the de-ionized water storage tanks on the fourth floor or worry about cross-contamination because of a lack of space for separate rooms for the discrete stages of molecular analyses (a testing process now used for everything from influenza to mumps).

“People are certainly more productive in the new facility,” said Waddell. Moreover, he said, “It’s a lot more pleasant to work with natural daylight than under artificial light (in the windowless laboratory rooms of the old building).”

New Facilities Bring Increased Safety, Security

The new Arizona laboratory was also designed with safety and security features that were never considered, or even available, when Waddell’s former workplace was constructed:

- Segregated public-access and restricted-access areas with separate air-handling systems.
- Cardkey access to work areas. For example, only the bio-emergency response group has access to BSL-3 testing areas.

Continued on page 5
Building A Better Laboratory: Design Innovations

Modern public health laboratories are designed to accommodate expanding missions that encompass both routine and high-volume emergency testing for a broad range of agents and disorders. Warren Hendrickson, a principal of the laboratory design firm CUH2A, explained the innovations that make today’s public health laboratories more efficient, safe and adaptable than ever before.

Safety
Safety concerns inform virtually every design decision in modern laboratory construction. Everything from the layout of sample intake areas to the flow of exiting waste streams is planned to protect laboratory workers and the environment. All biosafety enhancements are built to strict federal standards. “Safety is first and foremost,” said Hendrickson.

Central Accessioning
A post-9/11 concept that was conceived during the design of Virginia’s state-of-the-art Division of Consolidated Laboratory Services’ building, Hendrickson calls central accessioning “the first line of defense for the laboratory.” Rather than routing samples directly to the scientists who will be testing them, central accessioning areas—typically located near the facility’s loading dock—provide a secure environment where samples can be unpacked, sorted by type, bar-coded and scanned into data entry systems, relieving scientists of these chores. Unknown samples are handled in an offshoot all-hazards area that is ideally located apart from the main facility. These samples are opened inside a multi-chamber safety device called a glove box, wherein larger samples can be aliquoted, screened and decontaminated, if necessary, before removal to the appropriate testing area.

Open Floor Plan
The most successful laboratory designs, according to Hendrickson, are “very clean and very simple.” An important organizing element is an open floor plan that facilitates teamwork and maximizes flexibility. Rather than place a wall around each laboratory section, the open floor plan accommodates multiple sections in one large room, with support rooms for auxiliary work or specialized testing requiring high-level safeguards. The design extends the useful life of the building by allowing rapid reconfiguration of the work space—for either temporary or long-term use—on demand and at minimal cost. Testing areas in both Virginia and Arizona, for example, are outfitted with overhead service carriers that house electrical outlets, data ports, fume extractors and specialty gas lines so that floor space is completely free to position and reposition equipment on movable tables below. “We’ve kind of unplugged the laboratory,” said Hendrickson.

Glass
Glass windows and glass partitions are a boon for many reasons. “Having views to the outside helps people to stay aware and brings in natural light, cutting down on lighting costs,” Hendrickson said. Glass walls between testing areas and hallways allow laboratorians to “see and be seen for safety.” (Of course, all of this glass is high-performance, with good thermal properties.)

Emergency Management
After anthrax, SARS and hurricane Katrina, staging an emergency response has come to be a critical laboratory function. Well-designed facilities can handle streams of emergency vehicles, couriers and journalists, as well as large volumes of event samples, all while important everyday work continues. One innovation is a conference room/auditorium that doubles as an emergency management call center.

Training Laboratory
A dedicated training laboratory makes it easier for scientists to become certified for BSL-2 and BSL-3 work and to keep their skills current. The Arizona laboratory has satellite and Internet capabilities so that training sessions can be recorded and burned onto CDs. It is also equipped with systems that allow trainers to project images seen through microscopes onto a plasma screen, to reproduce microscopic images on DVD and to perform real-time editing. A crucial bonus is the laboratory’s ability to function as a BSL-3 suite for surge capacity. The training laboratory, said Hendrickson, “is a non-routine lab space that’s starting to be very important in the building.”

Energy Efficiency
Energy efficiency is no longer an afterthought in laboratory design. The Pennsylvania Environmental Laboratory was built to meet the stringent requirements necessary to earn a gold Leadership in Energy & Environmental Design (LEED) award from the US Green Building Council, and the new facility planned to house Iowa’s public health laboratory may achieve LEED gold standards. Iowa planners are considering the use of control systems that monitor natural light and dim the electric lights if the natural light is sufficiently bright. Arizona’s public health laboratory has louvered overhangs that move in sync with the solar angle throughout the year to minimize heating and cooling costs. Hendrickson noted that many state laboratories are adopting energy-saving features even though not all states are interested in going through the process of LEED certification.

*CUH2A is a corporate APHL member and has worked on various aspects of the planning and/or construction of public health laboratories in 18 states, including Arizona, Iowa and Virginia.
• An elaborate network of cameras inside and outside the building. “We want to keep track of who’s in the building in case we have to evacuate and in case a sample is taken from the building,” said Waddell. “For chain-of-custody purposes we can go back and look at who had access to samples. If there’s cross-contamination of a sample, we can go back and look at camera records for quality control purposes.”

• A comprehensive building management system that allows authorized staff to view all the doors in the facility in real-time, to monitor air flow and energy use and to check ambient temperatures in refrigerators and other storage units. “If there’s an exhaust fan that’s slowing down and about to go out, we know it,” said Waddell. Many controls can be reset electronically either on- or off-site.

• Uninterrupted power sources for tandem mass spectrometers and other sensitive equipment.

• A 750 kilowatt diesel-powered back-up generator that will temporarily power all of its chemical fume hoods, biosafety cabinets, lights, refrigerators, freezers and incubators in the event of an emergency.

Laboratorians, Legislatures Must Work Together

Because the last public health laboratory building boom occurred between 1950 and 1970, many states must now deal with a deteriorating laboratory infrastructure in one way or another: either, like Arizona and Iowa, by investing in new facilities better suited to laboratories’ evolving missions and technology needs, or by making do with what they have. The decision comes down to funding.

Lou Turner, director of North Carolina’s state laboratory, has been lately walking the halls of the North Carolina legislature to persuade lawmakers to replace her 34-year-old building. “We are in critical need,” she said, “because when the building was built, 75% of the work we did was manual. Now 75% of our work requires exquisitely dedicated power sources.” A feasibility study pegs the cost of an appropriate new facility at $100 million—not an insignificant sum. Turner said working with the legislature has been “a strenuous and very political process because we’re competing (for funding) with mental health hospitals and other needs for our citizens.” The support of the state health officer and secretary of health and human services has helped. So has a trip for legislators to Virginia’s three-year-old Division of Consolidated Laboratory Services—a CUH2A-designed facility that Hendrickson calls “a heavy hitter” in terms of testing capacity and technology. Turner is hopeful that funding will be approved.

Funds for Iowa’s new laboratory were approved by that state’s legislature in May after a lengthy campaign. It helped that the laboratory had amassed tremendous goodwill among Iowa businesses, and the Iowa City-Cedar Rapids-Coralville Chamber of Commerce made a new public health laboratory its top priority.

Building Relationships with Business

Construction of a large-scale building will provide a boost for the local economy, and the new facility will enable the Iowa public health laboratory to continue its lengthy record of community service. When anthrax was sowing panic across the country, for example, the lab tested a number of unidentified powders for Rockwell Collins, a government defense contractor based in Cedar Rapids. “Their employees were afraid of the powders that were coming in on their component parts,” said Gilchrist. “We accepted their samples and tested them even if they weren’t deemed a credible threat. We said if (a powder) was going to shut down the local economy it was a credible threat.” The company says the lab averted millions of dollars in lost production.

Similarly, when a local chicken processing plant lost some of its laboratory workers, the lab agreed to test its waste water until new employees could be hired and trained. “We’re members of the chamber of commerce,” said Gilchrist. “We try to be there when we can.” Finally—after many “crumbling infrastructure” tours—Gilchrist made a compelling case that it was too risky not to upgrade the public health laboratory. After all, SARS cost Toronto almost a billion dollars in lost trade and tourism partly because of limited laboratory capacity. “If pandemic flu strikes Iowa,” Gilchrist told the legislature, “it’s going to be a Category 5 storm and the levee is broken. If we get the money this year, it’s going to be at least 2009 before we get a new building. We’re going to be lucky to beat the pandemic.”

Gambling revenue will fund the new facility, which cost several million dollars to design and is estimated to cost $36 million to build on land donated by the University of Iowa. It will be based on an open floor plan concept that Gilchrist likens to Lego® land: “When there’s new technology, you just open the box and get some more Legos out and redesign your area a little bit.” Adjacent spaces will house boats (used for water testing) and provide space for air testing and all-hazards receipt. The multi-use spaces will easily convert into staging areas for bioterrorism and chemical terrorism response, if needed—a huge luxury compared to the lab’s current constrained quarters.

In New Mexico, as in Iowa, the private sector played a pivotal role securing funds for a public health laboratory that is now nearing construction. In New Mexico, however, it was a private industry whose support the lab did not actively court. Dave Mills, director of the state’s Scientific Laboratory Division, said, “The dairy lobby wielded the 800 pound hammer. They carried (the $80 million funding bill) through for us. It went legislator by legislator and they got it through at the 11th hour.”

The New Mexico dairy industry is the eighth largest in the country, and 70% of its milk production moves out of state. But, as Mills pointed out, “If you don’t have an FDA-approved lab testing this [milk], 0% moves out of state.” And the public health laboratory is the sole FDA-approved milk testing lab in New Mexico.
When conditions in the 34-year-old laboratory deteriorated to the point that its FDA certification for dairy testing seemed likely to be threatened, the dairy industry made the lab’s cause its own. Mills said, “Five years ago if someone said ‘You know who’s going to get you this building? It’s going to be the dairy lobby,’ I would’ve been stunned. The dairy operation is maybe 10% of the function of the laboratory.”

Balancing Accessibility, Safety and Partnerships

But funding was just the first challenge. After that legislative success, it took the state almost three years to negotiate with the University of New Mexico—the current site of the lab—for a new spot on campus. Personnel changes at the university at first slowed the process, but were followed by further changes that have now hastened it. Final negotiations continue.

The likely laboratory location—at the far end of a patch of undeveloped land—serves the needs of both parties. The university will gain state support for the road, sewer lines and other infrastructure necessary to develop the site, and the laboratory will gain a spot that balances its needs for public access and security.

The new laboratory will come just in time. New Mexico’s population has doubled since the current facility was constructed and Mills said, “We’re bursting at the seams.” Because the laboratory performs traditional public health testing as well as veterinary testing, forensic toxicology and environmental testing, all manner of samples—from human corpses to cattle—come and go through the building. Worker safety is a concern.

The building’s physical plant is outmoded. It was never intended to support the unidirectional work flow needed for DNA testing or to meet post-9/11 federal regulations governing select agents. The bottom line, said Mills, is that without a new building, the laboratory’s business operations are in jeopardy; not only its milk testing certification, but other certifications and licensures would eventually be pulled.

The planned new facility will draw upon many of the features of the Arizona public health laboratory, which Mills’ architects and building engineers have toured. Instead of one ad hoc BSL-3 workroom, the new laboratory will have as many as eight, including perhaps two dedicated to agricultural testing, for which the biosafety requirements are more stringent than for clinical testing. The agricultural biosafety suites will facilitate the laboratory’s surveillance for exotic Newcastle disease in chickens along the US border, an activity the state began this past year at the behest of the USDA.

Air balance will be a paramount concern. The building design includes progressively negative air pressure from hallways to biological testing areas and progressively positive air pressure in areas where dust must be excluded, such as air quality laboratories where particulate matter is monitored and examined for toxic, microscopic contaminants.

The new building will also address security concerns. Like the current structure, it will house three separate state agencies engaged in laboratory work. “You can’t just have one security perimeter to keep everybody out,” said Mills. “We need to be able to secure the area of each of the three agencies without hindering building functions.”

Anticipating the Unknown

But while a new building solves many problems, as others have discovered, it is not the end of the story. Dave Butcher, director of the Colorado Laboratory Services Division, operates from a structure that was gutted and completely redesigned just 10 years ago (before he joined the staff). The entire renovation cost the state less than $12 million, including the cost of the property, which the US Air Force sold to Colorado for $1.00. A bargain.

Yet the redesign did not anticipate recent changes in the public health laboratory mission. Said Butcher, “There was no way for them to know before 2001 that they would be working with large volumes of samples that might contain anthrax.” Butcher has also discovered that many features were “value-engineered out,” such as passive solar panels, a public address system and solar shields for south-facing windows.

The state has had to ante up additional funds to add required post-9/11 security features back in, including the public address system and an electronic keycard access system. The laboratory has also added exterior 3M® film on windows to reduce cooling costs and is in the process...
of correcting ventilation problems in its chemistry laboratory.

The good news is that the original overhaul left roughly 20,000 square feet of unfinished space for future development. The bad news, however, is that the state is unable to fund the estimated $3 million needed to outfit part of that space as an all-hazards triage and response lab. Butcher said, “I still feel it’s a safe facility, but I couldn’t handle large volumes of bioterrorism work here without jeopardizing the ability to perform other lab work.”

The lesson learned? “It’s important to anticipate future needs and get it down right the first time, because you may not get a second shot at the money.”

“If pandemic flu strikes Iowa,” Gilchrist told the legislature, “it’s going to be a Category 5 storm and the levee is broken.”

Even in Arizona’s newer public health laboratory, Waddell said he would have done a few things differently: install a larger back-up generator capable of powering the air conditioning, locate the all-hazards receipt area off-site and add ports for vaporized hydrogen peroxide (used to decontaminate a workspace) to the tuberculosis and virology testing areas. Already, the Arizona laboratory has purchased four point-of-use coolers to prevent the building from overheating during a power outage and has also revamped the security camera system so that high-resolution images can be stored for 30 days or longer.

**A Building Is Only As Good As Its People, Equipment**

A final lesson is that the laboratory building will never deliver full value without an appropriately trained staff and equipment. In order to get funding for the new Colorado laboratory building, Butcher’s predecessor had to give up the lab’s equipment budget. “The last good influx of equipment they had in chemistry was in 1988,” said Butcher. “When I came here in 2000 they were still using that same equipment. They couldn’t get parts for some of it.”

He reckons that a piece of analytical equipment has a life span of about seven years under the rigors of high-volume work. After that, it’s outdated, breaks down more frequently and costs more to repair.

Iowa’s Gilchrist said that her lab staff have been working 12 hours/day, 7 days/week to process specimens related to an ongoing mumps outbreak. “Influenza would be like a wildfire compared to the mumps,” she said, given its shorter incubation period and faster onset of symptoms.

She would like to convert to newer testing technology to reduce test turnaround times to just 24 hours for all emerging diseases. Rapid specimen delivery, 24-hour testing and automated reporting would make test results available within a day of specimen collection, thereby providing more time to act before an epidemic consumes the state.

“We want to make that our new standard,” she said. “We need funding for that: newer equipment, trained staff, more reagents. The mumps epidemic cost us about $250,000 just in reagents, the chemicals used for tests.”

A national shortage of laboratory scientists has plagued public health laboratories across the country. Mills has had to post and re-post and re-post” job listings to fill vacancies from a shrinking pool of candidates. When recruiting, he said, “It helps to have a facility that’s not scary; a facility where the people there can at least get the work done.”

As Butcher remarked, “The building’s only a piece of it. You need the staffing and you need the equipment. And that’s an understatement. But a building’s a start.”

**A Building Boom?**

States with labs built within the past 10 years (most within the past five years):
- Alaska
- Arizona
- California
- Colorado
- Georgia
- Hawaii
- Minnesota
- North Dakota (annex)
- Ohio
- Texas
- Virginia
- Wisconsin

States in which new labs have been approved and are being planned and/or constructed:
- Arkansas
- Connecticut
- District of Columbia
- Indiana
- Iowa
- Missouri
- New Jersey
- New Mexico
- North Carolina
- Vermont
- Wisconsin

State with legislature deliberating the funding of a new lab:
- Utah

*This list is based on anecdotal information and is not necessarily complete.

**Moved into one new building in 1999 and is in the process of expanding into a second new building.