Table 12 – ISB Lessons Learned

Lessons Learned	Description, Impacts and Solutions
Top Three Successes	
Funding Profile	• Program improvement of the project funding profile by allocating American Reinvestment and Recovery Act (ARRA) funding greatly reduce risk by forward funding the project. • The receipt of ARRA funding also allowed for early site clearing and site preparation activities to take place in advance of the building construction thereby eliminating the risk of underground unknowns early in the project.
In-house CM Services	• Experienced resource availability within BNL lended itself to performing construction management, quality assurance and inspection services with in-house personnel. • Highly-qualified, knowledgeable, dedicated field inspectors ensured work planning and control processes were being implemented, materials delivered and installed conformed with the approved submittals and that the work was in compliance with the contract documents. • The use of in-house CM services was advantageous to the project as this staff is familiar with the processes and procedures at the laboratory. • In-house staff is also knowledgeable in the coordination and communication required to support utility shutdowns and tie-in's of services. • The in-house construction management resources were further augmented by the active involvement and consultation with the BNL subject matter experts, Fire Protection Authority Having Jurisdiction and Chief Electrical Inspector for the Laboratory.
Visual As-Builts	• Consider photo documentation services which will provide the ability get ROI by monitoring the project more closely, for use as an on-line collaboration tool when issues arise during construction and as a valuable maintenance tool for facility managers. • The ISB project executed a subcontract to provide inspection- grade, high resolution photo documentation, linked to the architectural drawings, and certified for date and content. • This was extremely valuable during construction and will serve as a permanent record of visual as builts for the facility manager and for future maintenance, expansion or modification of the facility.

Top Three Potential Improvements	
Improve Schedule Development, GC Schedule Integration with the Project Baseline and General Contractor understanding of Earned Value Reporting Requirements	• It typically takes on average at least three months to develop and adequate, contract compliant construction schedule baseline. • Subcontractors typically do not have a good understanding of the impacts to the overall project earned value reporting indices and the affect their schedule has on the Earned Value monthly performance figures. • General contractors are not required to specify or disclose schedule contingency in their schedule. It is under their ownership during construction. • The GC's have a tendency to schedule activities early, knowing that they are not on or near the critical path and delays in performing those activities will not impact the overall construction schedule. This can however significantly affect a projects EV cost and schedule performance data. • The ISB Project conducted a training session for the General Contractor personnel. This provided a better understanding of the purpose of EV reporting and the necessity to schedule work in a realistic manner. • The General Contractor revised their baseline work-to-go accordingly and kept the project on track for EV reporting.
Improve GC and subcontractor compliance with ARRA Buy American Requirements	• Early clarification and understanding of the restrictions associated with the more stringent ARRA Buy American Act (BAA) regulations would have reduced rework and delays associated with identification of compliant materials during the construction phase. • The varying interpretations of the regulations by material and equipment suppliers created delays in submittal approvals. Many of the AE basis of design materials and equipment such as the elevator, fumehoods, casework, floor tile, countertops, fire alarm system components, transformers, etc,…were not in compliance with the more stringent ARRA BAA regulations. This did not come to light until the submittal phase of construction. • Extensive reviews of substitution requests during the submittal phase caused delays. Procurement support was required to issue announcements in Fed Biz Ops when compliant material was not able to be identified by the AE or the general contractor. • Updating of the A/E standard specifications library to ensure compliance with the ARRA BAA regulations would have presented significant cost and schedule delays in the design phase and would have delayed contract award. • The project was successful in managing this issue by working in collaboration with BNL procurement and legal staff as well as with the A/E and General Contractor. The general contractor was proactive in making timely decisions on material and equipment subcontract vendors to minimize schedule or cost impacts on the project. The General Contractor and AE were supportive and did not submit claims associated with this effort, but this would not always be the case.
Accelerated Schedule	• The Project was required to accelerate construction contract award by three months to receive ARRA funding. This, in combination with late PED funds due to a long Continuing Resolution, drove the need to compress the design phase of the project. • Consequently, the final design was not as detailed and not as coordinated as expected.

	• This resulted in many Request for Information documents submitted by the General Contractor and Engineering Change Notices by the AE. The cost and schedule risks associated with accelerating the schedule were not fully realized. • Time gained to accelerate contract award was lost and costs were realized as a result of the many engineering change notices required to correct the design documents.
Other	
Change in Project Management Personnel	• The project identified the change in project management personnel on the risk registry from the early stages of the project. • This risk was realized with the loss of the BNL Project Director during the design phase of the project and the loss of the BNL Construction Manager during the construction phase of the project. In addition, due to a slowing economy, the AE also reduced staff between the design and construction phase. The General Contractor also experienced a loss in the field superintendent position. • Effective communication and documentation practices ensured smooth transitions and no loss in continuity. The positions were quickly backfilled by the A/E, General Contractor and BNL to ensure appropriate resourcing was assigned for executing a project of this magnitude.
Integrated Project Team	• The project benefited from the active participation of the Facility Complex Manager and Facility Project Manager (FPM) in the weekly IPT meetings and the weekly construction meetings. • The active engagement of the FPM in the field during construction was beneficial from a maintainability and reliability standpoint. • This partnership with the Complex was key to ensuring a smooth transition to operations and enabled their staff to gain familiarity with the building construction prior to turn over for maintenance.
High Performance Variable Air Volume Fume Hoods	• Use of VAV fumehoods in conjunction with the Building Automation System will allow the capability to gain a better understanding of the utilization factor of high energy use equipment such as fumehoods. • In ISB, this has allowed the project to increase efficiency and reduce operating costs. The data will be collected and shared with the respective scientific departments.
Value Engineering Process	• Ensure that operating costs are considered and analyzed in the VE process. When applying value engineering principles to achieve best value, the line items with the highest initial cost are often those that are first considered for elimination. • Projects should ensure that energy savings features such as heat recovery and/or variable air volume fumehood exhaust system are not completely engineered out of the design. These systems are not easily added later with contingency unless adequate space was reserved. Eliminating these key features will have a longterm effect on operating costs. During the VE process for ISB, features such as heat recovery and VAV fumehoods were removed from consideration as a potential cost savings VE item.

In-house Construction Safety Oversight	• Dedicated ES&H oversight was budgeted into the project from early in the planning stages. • The support and services received from the ES&H directorate exceeded expectations. • The dedicated resource accelerated the development and approval of subcontractor Phase Hazard Analysis documents as well as the contractors Health and Safety Plan. • Daily field safety inspections were performed and deficiencies corrected or addressed immediately. • The early recognition and budget set aside for construction safety support ensured safe work practices in the field and reduced the potential for injuries.
Subcontractor Training	• BNL ES&H personnel successfully provided project tailored training for the subcontractor personnel. • Training was provided in Earn Value Methodology, BNL Lockout/Tagout requirements and procedures and Electrical Installation work practices. Special emphasis was placed on requirements within BNL's SBMS that are more stringent that the building codes. • Lessons learned from other ongoing and past projects were discussed and shared with the Contractor personnel. • Establishing project tailored training helped to ensure workmanship in the field is code compliant and meets BNL expectations.
Pre-BORE walkthroughs & Active Engagement of Subject Matter Experts	• Pre-BOREs are normally performed at BNL for projects of this magnitude to ensure there are no unanticipated issues arising during the formal BORE(s). • The ISB Project has benefited both from NSLS-II lessons learned and from active engagement of the BNL Subject Matter Experts throughout the design and construction phases of the project. • The project has conducted weekly pre-BORE walkthroughs for several months before the final BORE took place. • This was advantageous to the project by identifying potential preoccupancy findings early and by providing the project and subcontractor adequate time to address the findings before the final inspection.
Automatic Sash Closers on Fumehoods	• Consider use of automatic sash closing sensors on fumehoods. This in combination with the high performance V ariable Air Volume fumehoods will reduce operating costs significantly.
Full-time Subcontractor Safety Professional	• The Project required the General Contractor to provide a full time dedicated construction safety professional. This was advantageous to the Project and to BNL. • The additional full-time safety oversight from the General Contractor in addition to the project based safety oversight and off project ES&H personnel helped to enforce the safety culture.
Construction	• The ISB is a cast-in-place concrete structure with the exception of the mechanical penthouse which is lightweight joist construction supported by steel columns. • During the MEP coordination process the General Contractor requested confirmation from the AE structural engineer of record, that the joists can support the excessive MEP loads.

	• The A-E structural engineer of record did not fully coordinate with all disciplines when developing the load table for the joist design. As a result, the fabricated and installed joists were under-designed and required strengthening and reinforcement. • This resulted in a significant cost and schedule impacts. • Mechanical spaces in laboratory buildings typically have heavy loads associated with ductwork, chilled water piping, electrical conduits, etc.. Projects should consider against using lightweight steel joist design.
Lab Design	• Where possible, adopt a standardized design approach for routing of MEP services into the laboratories spaces. • Uniformity in the layout of MEP services and equipment in the lab and galley spaces will ensure maintainability and accessibility of installed equipment such as VAV boxes. This will also greatly reduce the potential for code violations in particular with electrical junction boxes and dedicated space required for power panels. • Use of BIM during construction is a potential solution to this problem, however, requiring BIM during construction may also limit the pool of available bidders and subcontractors which may drive the costs up.
Lab Planning during Design Phase	• Include the mechanical and electrical engineers in addition to the A/E lab planners in the lab planning sessions with the scientific staff. • This will ensure that the proper power, exhaust and gases are designed into the building early and reduce the potential for changes after beneficial occupancy .
Design /Construction	• The project would have benefited from a conduit embedment plan as part of the design documents. • Embedded piping and conduits were not fully coordinated in the design documents which resulted in change orders and the need to redesign the intended finish of exposed concrete surfaces. • The AE did not fully coordinate lighting conduits in particular to ensure that conduits and/or sleeves were set and cast into the concrete.
Demolition	• The project demolished an unoccupied WWII era army building to meet space offsetting requirements. Mold survey results inside the building triggered the need for qualified tradesman fit tested for respirators. • This severely limited the pool of available qualified resources and resulted in cost and schedule impacts. Utilities within the building needed to be exposed, traced and isolated before demolition could take place. • The Project initiated an interdepartmental resource sharing initiative to provide qualified tradesman to keep project on schedule. • Consider environmental conditions within existing structures and conduct early planning to ensure the availability of qualified resources.
Demolition	• Post asbestos floor tile removal surveys in facilities scheduled to be demolished revealed that the mastic from asbestos floor tile was not able to be fully removed from the concrete subfloor below. • The concrete was initially planned to be recycled onsite which would have

	resulted in a substantial cost savings to the project. • The unforeseen added costs for trucking and offsite disposal of the concrete slabs resulted in a significant cost impact to the project.
Demolition	• Thirty cottages were demolished as part of the project scope to meet space offsetting requirements. There was a sanitary drywell associated with each one of the cottages that required closure. • The cottages were used as residential/recreational facilities, and therefore, the project did not anticipate there to be contamination in the drywells. • Sampling collected revealed high levels of semi-volatiles which required several remediation efforts prior to closure. • Early sampling of drywells would have prepared the project for the costs impacts associated with remediation and disposal of contaminated soils. •
ARRA Compliant Material and Equipment Flowdown to Distributers	• Distributors of materials and equipment have multiple fabrication and supply sources. Subcontractors must be mindful to ensure they specify "American manufactured goods only" when ordering materials and equipment. This is difficult to track since BNL is does not see copies of these purchase orders. • It becomes incumbent on the BNL field inspectors to ensure quality assurance inspections are done thoroughly and that materials delivered match the approved submittal. • General contractor on ISB project was issued a nonconformance associated with fiberglass rebar. The approved submittal was ARRA BAA compliant, but the distributor shipped rebar from Canada. The rebar was installed by the subcontractor and had to be removed and replaced. This presented a cost impact to the subcontractor for which they were not compensated.