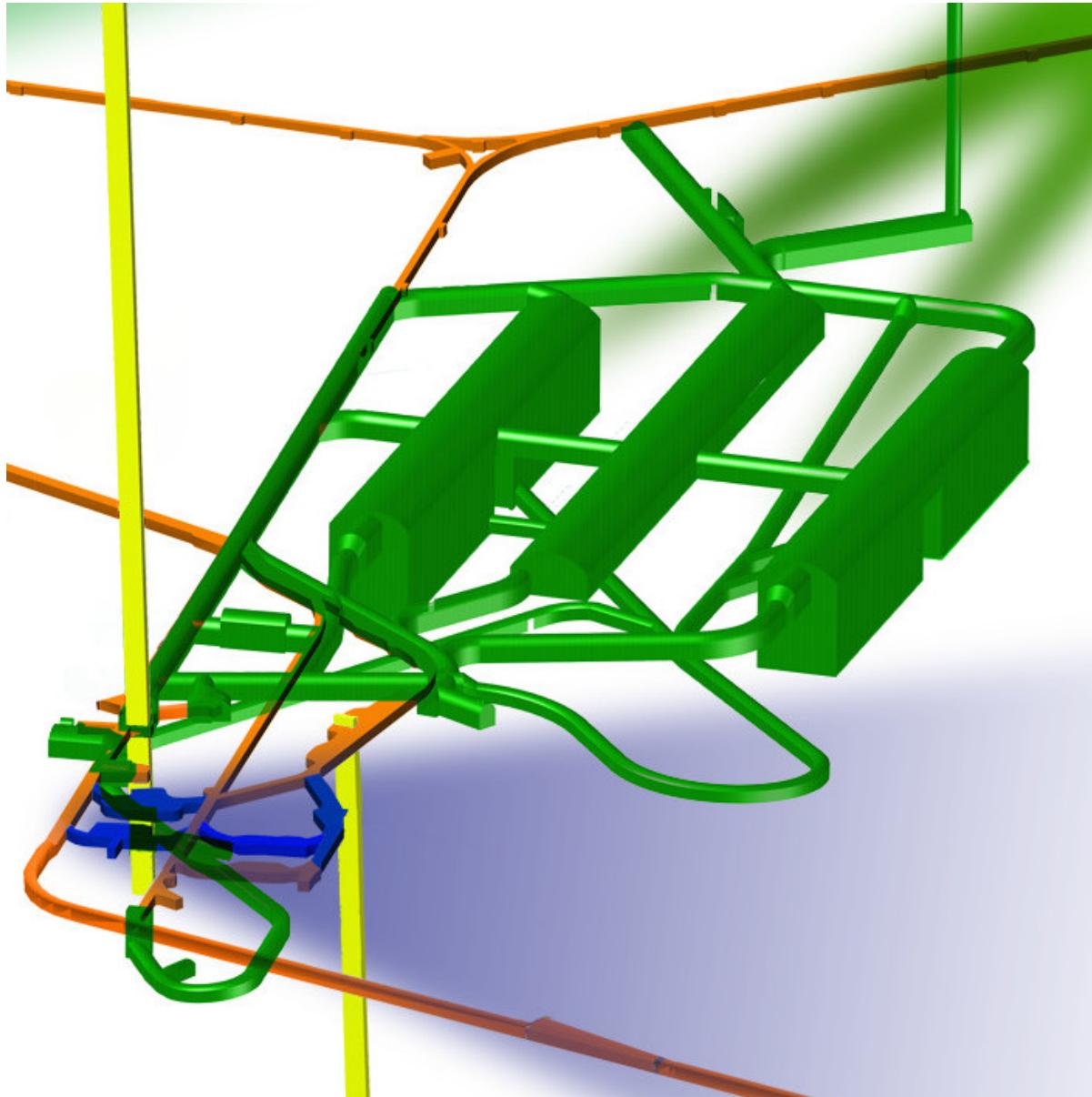


<sup>1</sup>  
<sup>2</sup>  
The Long-Baseline Neutrino Facility (LBNF)  
Far Site Conventional Facilities

<sup>3</sup>  
Preliminary Design Report



<sup>4</sup>

<sup>5</sup>

October 8, 2015



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3 where are these defined? . . . . .	12
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23 reference cryo design doc . . . . .	26
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30 because it's not heated now? Is this so that people can work in it? . . . . .	31
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33 'minor demolition'? sounds like an oxymoron . . . . .	31
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# <sup>1</sup> Chapter 1

## <sup>2</sup> Introduction

cf-intro

tro-fscf

### <sup>3</sup> 1.1 The Long-Baseline Neutrino Facility for DUNE

<sup>4</sup> The global neutrino physics community is developing a multi-decade physics program to measure  
<sup>5</sup> unknown parameters of the Standard Model of particle physics and search for new phenomena.  
<sup>6</sup> The program will be carried out as an international, leading-edge, dual-site experiment for neutrino  
<sup>7</sup> science and proton decay studies, which is known as the *Deep Underground Neutrino Experiment*  
<sup>8</sup> (*DUNE*), supported by the *Long-Baseline Neutrino Facility* (*LBNF*).

<sup>9</sup> To achieve its ambitious physics objectives as a world-class facility, this program has been conceived  
<sup>10</sup> around three central components:

- <sup>11</sup> 1. an intense, wide-band neutrino beam
- <sup>12</sup> 2. a fine-grained near neutrino detector just downstream of the neutrino source
- <sup>13</sup> 3. a massive liquid argon time-projection chamber (LArTPC) deployed as a far neutrino detector  
<sup>14</sup> deep underground, 1,300 km downstream; this distance between the neutrino source and far  
<sup>15</sup> detector – the *baseline* – is measured along the line of travel through the Earth

<sup>16</sup> The neutrino beam and near detector will be installed at the Fermi National Accelerator Laboratory  
<sup>17</sup> (Fermilab), in Batavia, Illinois. The far detector will be installed at the Sanford Underground  
<sup>18</sup> Research Facility (SURF) in Lead, South Dakota. The experiment’s detectors at the two sites will  
<sup>19</sup> be designed, built, commissioned and operated by the international DUNE Collaboration. LBNF  
<sup>20</sup> is the facility designed to support the experiment. LBNF will comprise

- <sup>21</sup> • the world’s highest-intensity neutrino beam at Fermilab
- <sup>22</sup> • a set of underground caverns to house the DUNE far detector modules at SURF
- <sup>23</sup> • a beamline measurement system at the near site

- 1     • conventional facilities at both the near and far sites
  - 2     • cryogenics infrastructure to support the DUNE detector at the far site
- 3 LBNF is hosted by Fermilab and its design and construction is organized as a DOE/Fermilab  
4 project incorporating international partners.

## 5 **1.2 Strategy and Requirements**

6 The strategy for executing the scientific program was presented in the LBNF/DUNE Conceptual  
7 Design Report (CDR)<sup>cd-r-cdr</sup>[1]. The program has been developed to meet the requirements set out in the  
8 P5 report<sup>p5-report-2014</sup>[2] and takes into account the recommendations of the European Strategy for Particle  
9 Physics<sup>euro-strat-2013</sup>[3]. It adopts a model in which U.S. and international funding agencies share costs on  
10 the DUNE detectors, and the European Organization for Nuclear Research (CERN) and other  
11 participants provide in-kind contributions to the supporting infrastructure of LBNF. LBNF and  
12 DUNE will be tightly coordinated as DUNE collaborators design the detectors and infrastructure  
13 that will carry out the scientific program.

14 The requirements on LBNF derive from the DUNE Collaboration science requirements<sup>dune-sci-req</sup>[4], which  
15 drive the space and functional needs of the far detector construction and operation, and from  
16 Environment, Safety and Health (ES&H) and facility operations requirements. The LBNF and  
17 DUNE requirements are maintained together in<sup>dune-sci-req</sup>[4]. Conventional Facility requirements are detailed  
18 in the Arup 100% Preliminary Design Report<sup>arup:fsci100pdr</sup>[5].

19 The DUNE far detector is designed as a set of four 10-kt fiducial mass modules. The caverns and  
20 the services to the caverns will be as similar to one another as possible in order to implement  
21 efficiency in design, construction and operation. Figure 1.1 shows the layout of the underground  
22 caverns that will house the detector modules, and the separate cavern that will house utilities and  
23 cryogenics systems.

24 While the SURF site already meets many of the requirements from the geological, scientific and  
25 engineering standpoints, significant work is required to provide the space and infrastructure for  
26 the experiment's installation and operation.

27 This PDR presents the scope of the LBNF Far Site Conventional Facilities (FSCF) at SURF, the  
28 present and future states of the site, evaluation and assessment of its facilities and the provisioning  
29 of associated infrastructure such as power, water, plumbing, ventilation, etc. Also described are  
30 the tasks and processes planned for developing the surface and underground structures and the  
31 requisite safety measures.

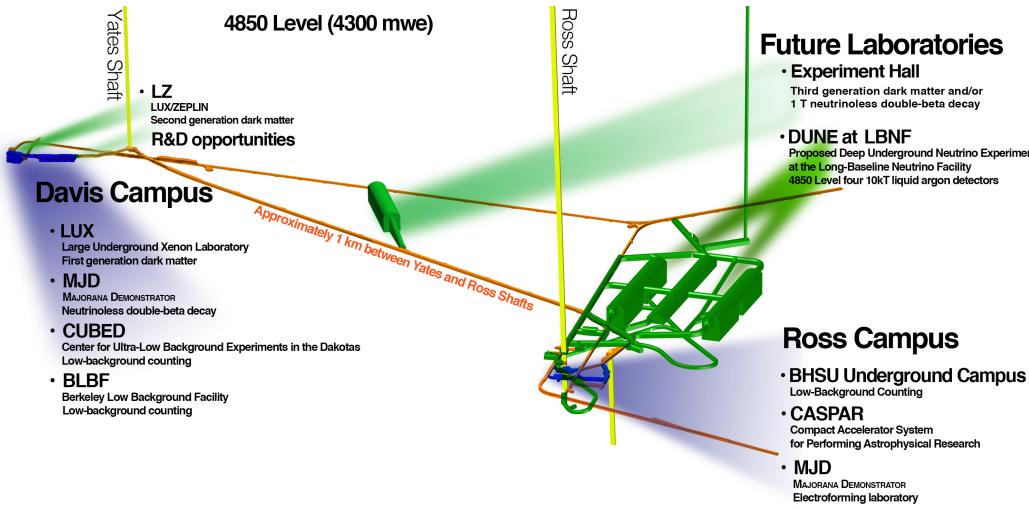


Figure 1.1: Underground cavern layout (SRK, Courtesy SURF)

fig:unde

## 1.3 Introduction to the Far Site Conventional Facilities

- 1 The scope of the FSCF includes design and construction for facilities on the surface and under-  
2 ground at SURF for DUNE.
- 3 The primary element of the Far Site Conventional Facilities (FSCF) is the set of underground  
4 spaces required to install, operate and support the multi-module cryogenic DUNE far detector.  
5 The underground conventional facilities include new excavated spaces at the 4850L for the detector  
6 modules, utility spaces for experiment equipment, utility spaces for facility equipment, drifts for  
7 access, and spaces required for construction. Underground infrastructure that FSCF must provide  
8 for DUNE includes power to experiment equipment, cooling systems for that equipment and cy-  
9 berinfrastructure for data collection. Underground infrastructure required for the facility includes  
10 domestic (potable) water, industrial water for process use and fire suppression, fire detection and  
11 alarm systems, normal and standby power systems, a sump-pump drainage system for native and  
12 leak water around the detector, water drainage to the facility-wide pump discharge system, and  
13 cyberinfrastructure for communications and security. In addition to providing new spaces and  
14 infrastructure underground, FSCF enlarges some existing spaces for use, such as the access drifts  
15 from the Ross Shaft to the new caverns, and provides infrastructure for these spaces. New piping  
16 is provided in the shaft for cryogens (gas argon transfer line and nitrogen compressor suction and  
17 discharge lines) and water as well as for power cables and cyberinfrastructure.  
18
- 19 About 50 buildings and utilities exist above-ground at SURF, a few of which will be utilized  
20 for LBNF. The scope of the surface FSCF includes only that work necessary for LBNF; it does  
21 not include the general rehabilitation of buildings on the site, which remains the responsibility  
22 of SURF. Electrical substations and distribution will be upgraded to increase power and provide  
23 standby capability for life safety. An existing building will be remodeled to house both office  
24 space and an experiment/facility control room, and a new building will be constructed near the  
25 existing Ross Shaft to support cryogen transfer from the surface to the 4850L. To reduce the risk of

failure of aging but essential support equipment during the construction and installation periods, several SURF infrastructure-reliability activities are included in the earlier phases of the LBNF Project. These include completion of the Ross Shaft rehabilitation, rebuilding of hoist motors, and replacement of the Oro Hondo fan. Failure of any of this aging infrastructure could limit or stop access to the underground.

## 1.4 The LBNF Far Site CF Preliminary Design Report

The *LBNF Far Site Conventional Facilities Preliminary Design Report* describes the preliminary designs for the conventional facilities planned for the Sanford Underground Research Facility (SURF), the LBNF Far Site. This document is an evolution of *LBNF/DUNE CDR Annex 3C: Conventional Facilities (CF) at the Far Site*, which was prepared for the LBNF/DUNE CD-1-Refresh Review in July 2015. The original LBNF/DUNE Conceptual Design Report volumes have been updated [6, 7, 8, 9] as required to provide context for the LBNF Far Site Conventional Facilities design.

The scope of this Preliminary Design Report (PDR) is limited to the LBNF Far Site Conventional Facilities (FSCF); the cryogenics infrastructure is not included.

1. This chapter provides a short introduction to LBNF, DUNE and the FSCF.
2. Chapter 2 summarizes the management structure for LBNF.
3. Chapter 3 describes the existing site conditions at SURF.
4. Chapter 4 describes the existing and planned surface buildings that will support the DUNE far detector, planned for installation at the 4850L of SURF.
5. Chapter ?? discusses the planned underground excavation.
6. Chapter ?? describes the underground infrastructure necessary to facilitate installation and operation of the DUNE far detector modules.
7. Chapter ?? describes the restoration and maintenance activities required at the SURF site that are included in the overall LBNF Project and planned to be executed as early Site Preparation.

This PDR is supported by a Design Report from the independent engineering firm, Arup, USA[5].

# <sup>1</sup> Chapter 2

## <sup>2</sup> Project Management

intro-pm

### <sup>3</sup> 2.1 Project Structure and Responsibilities

<sup>4</sup> The LBNF Project is charged by Fermilab and DOE to design and construct conventional and technical facilities needed to support the DUNE Collaboration. LBNF is organized as a DOE/Fermilab project incorporating in-kind contributions from international partners. At this time, the major international partner is CERN, the European Organization for Nuclear Research. LBNF works closely with DUNE through several coordinating groups to ensure scientific direction and coordination for executing the LBNF Project such that the requirements of the program are met.

<sup>10</sup> LBNF works closely with SURF management to coordinate design and construction for the far site conventional facilities for the DUNE far detector. CERN is providing cryogenics equipment and engineering as part of the cryogenics infrastructure at SURF. The design and construction of LBNF is supported by other laboratories and consultants/contractors that provide scientific, engineering, and technical expertise. A full description of LBNF Project Management is contained in the LBNF/DUNE Project Management Plan<sup>[?]</sup>.

<sup>16</sup> LBNF coordinates with DUNE through regular technical team interactions between the two Projects as well as more formally through the Joint Management Team where day-to-day management coordination occurs, and the Experiment-Facility Interface Group, where major issues regarding interfaces and items affecting both Projects are discussed. In addition, the Projects share common Project Office staff and systems, and include a single, integrated project resource-loaded schedule and configuration management system.

<sup>22</sup> LBNF consists of two major L2 subprojects, Far Site Facilities and Near Site Facilities, coordinated through a central Project Office located at Fermilab. Each L2 Project consists of two large L3 subprojects corresponding to the conventional and technical facilities, respectively, at each site. The project organizational structure, which includes leadership from major partners, is shown in Figure ??.

<sup>27</sup> The LBNF Project team consists of members from Fermilab, CERN, South Dakota Science and

<sup>1</sup> Technology Authority (SDSTA), and Brookhaven National Laboratory (BNL). The team, including  
<sup>2</sup> members of the Project Office as well as the L2 and L3 managers for the individual subprojects,  
<sup>3</sup> is assembled by the Project Director. The Project team is shown in Figure 2.2. Line management  
<sup>4</sup> for environment, safety and health, and quality assurance flows through the Project Director.

<sup>5</sup> Through their delegated authority and in consultation with major stakeholders, the L2 Project  
<sup>6</sup> Managers determine which of their lower-tier managers will be Control Account Managers (CAMs)  
<sup>7</sup> for the Project WBS. L2 and L3 Project Managers are directly responsible for generating and  
<sup>8</sup> maintaining the cost estimate, schedule, and resource requirements for their subprojects and for  
<sup>9</sup> meeting the goals of their subprojects within the accepted baseline cost and schedule.

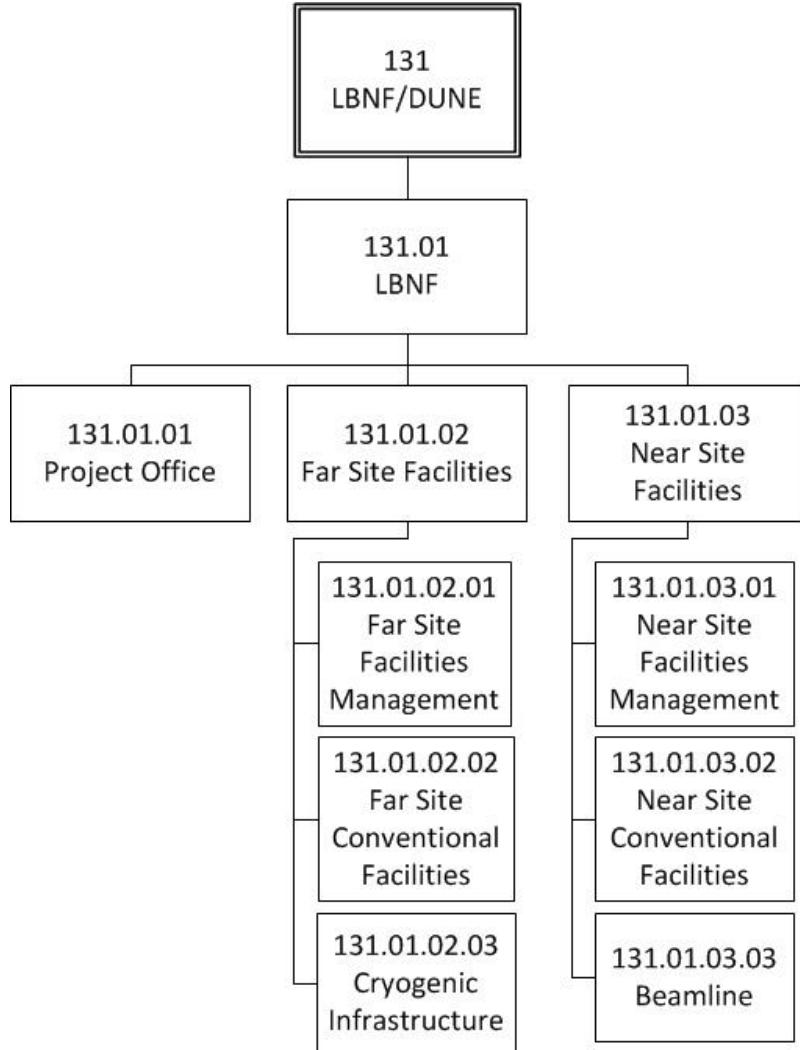


Figure 2.1: LBNF Work Breakdown Structure (WBS) to Level 3 (L3)

## <sup>10</sup> 2.2 SDSTA and SURF

<sup>11</sup> LBNF plans to construct facilities at SURF to house and support the DUNE far detector. SURF  
<sup>12</sup> is owned by the state of South Dakota and managed by the SDSTA.

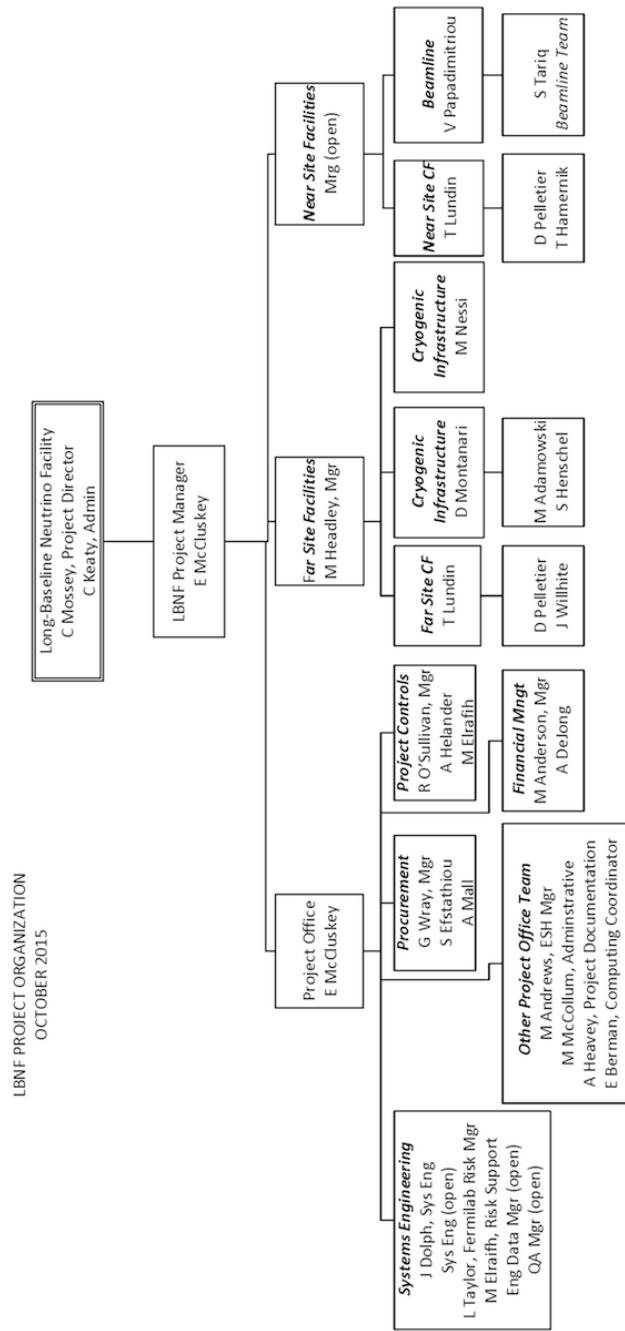


Figure 2.2: LBNF Organization

fig:lbnf

- 1 Current SURF activities include operations necessary for allowing safe access to the 4850L of the  
2 former mine, which houses the existing and under-development science experiments. The DOE  
3 is presently funding SDSTA ongoing operations through Lawrence Berkeley National Laboratory  
4 (LBNL) and its SURF Operations Office through FY16; starting in FY17 it is expected that this  
5 will change, and that funding will flow through Fermilab.
- 6 The LBNF Far Site Facilities Manager is also an employee of SDSTA and is contracted to Fer-  
7 milab to provide management and coordination of the Far Site Conventional Facilities (CF) and  
8 Cryogenics Infrastructure subprojects. LBNF contracts directly with SDSTA for the design of the  
9 required CF at SURF; whereas the actual construction of the CF will be directly contracted from  
10 Fermilab. Coordination between SDSTA and the LBNF Project is necessary to ensure efficient  
11 operations at SURF. This will be facilitated via an agreement between SDSTA and Fermilab (not  
12 yet available) that defines responsibilities and methods for working jointly on LBNF Project design  
13 and construction. A separate agreement will be written for LBNF Operations.

## 14 **2.3 CERN**

- 15 The European Organization for Nuclear Research (CERN) is expected to significantly contribute  
16 to LBNF with technical components that are required to support the deployment of both the  
17 DUNE detectors and the neutrino beamline.

## 18 **2.4 Coordination within LBNF**

- 19 The LBNF Project organization is headed by the LBNF Project Director, who is also the Fermilab  
20 Deputy Director for LBNF; this person reports directly to the Fermilab Director.

21 Within FermilabâŽs organization, the LBNF organization includes two new divisions – Far-Site  
22 Facilities and Near-Site Facilities – as well as a project office, all led by the LBNF Project Director.  
23 They have been created to execute the Far Site Facilities and Near Site Facilities subprojects. The  
24 heads of these divisions report to the LBNF Project Manager. Any personnel working more than  
25 half-time on these subprojects would typically be expected to become a member of one of these  
26 divisions, while other contributors will likely be matrixed into part-time roles from other Fermilab  
27 Divisions. The heads of the other Fermilab Divisions work with the L2 and L3 project managers  
28 to supply the needed resources on an annual basis.

29 The LBNF WBS defines the scope of work. All changes to the WBS must be approved by the  
30 LBNF Project Manager prior to implementation. The current WBS is shown in Figure 2.1. For  
31 work on specific tasks required for the LBNF Project at the SURF site, SDSTA assigns engineers  
32 and others as required. This is listed in the resource-loaded schedule as contracted work from  
33 Fermilab for Far Site CF activities. CERN and Fermilab are developing a common cryogenics  
34 team to design and produce the Cryogenics Infrastructure subproject deliverables for the far site.  
35 CERN provides engineers and other staff as needed to complete their agreed-upon deliverables.

1 LBNF has formed several management groups with responsibilities as described below. More detail  
2 is provided in the PMP

3 add citation, doc 117

4 .  
5 LBNF uses a *Project Management Board* to provide formal advice to the Project Director on  
6 matters of importance to the LBNF Project as a whole. Such matters include (but are not limited  
7 to) those that

- 8 • have significant technical, cost, or schedule impact on the Project
- 9 • have impacts on more than one L2 subproject
- 10 • affect the management systems for the Project
- 11 • have impacts on or result from changes to other Projects on which LBNF is dependent
- 12 • result from external reviews or reviews called by the Project Director

13 The Project Management Board serves as the

- 14 • LBNF Change Control Board, as described in the Configuration Management Plan [?]
- 15 • Risk Management Board, as described in the Fermilab Risk Management Procedure for  
16 Projects [?]

17 The Far Site CF (FSCF) Project has engaged three international experts in hard-rock underground  
18 construction to advise it periodically through the design and construction process regarding ex-  
19 cavation at SURF. This team, the FSCF *Neutrino Cavity Advisory Board (NCAB)*, meets at  
20 the request of the FSCF-PM, generally on-site, to discuss specific technical issues. The NCAB  
21 produces a report with its findings and conclusions for Project information and action.

## 22 **2.5 LBNF/DUNE Advisory and Coordinating Structures**

23 A set of structures has been established to provide coordination among the participating funding  
24 agencies, oversight of the LBNF and DUNE projects, and coordination and communication between  
25 the two projects. These structures and the relationships among them are shown in Figure 2.3 and  
26 are described in this section.

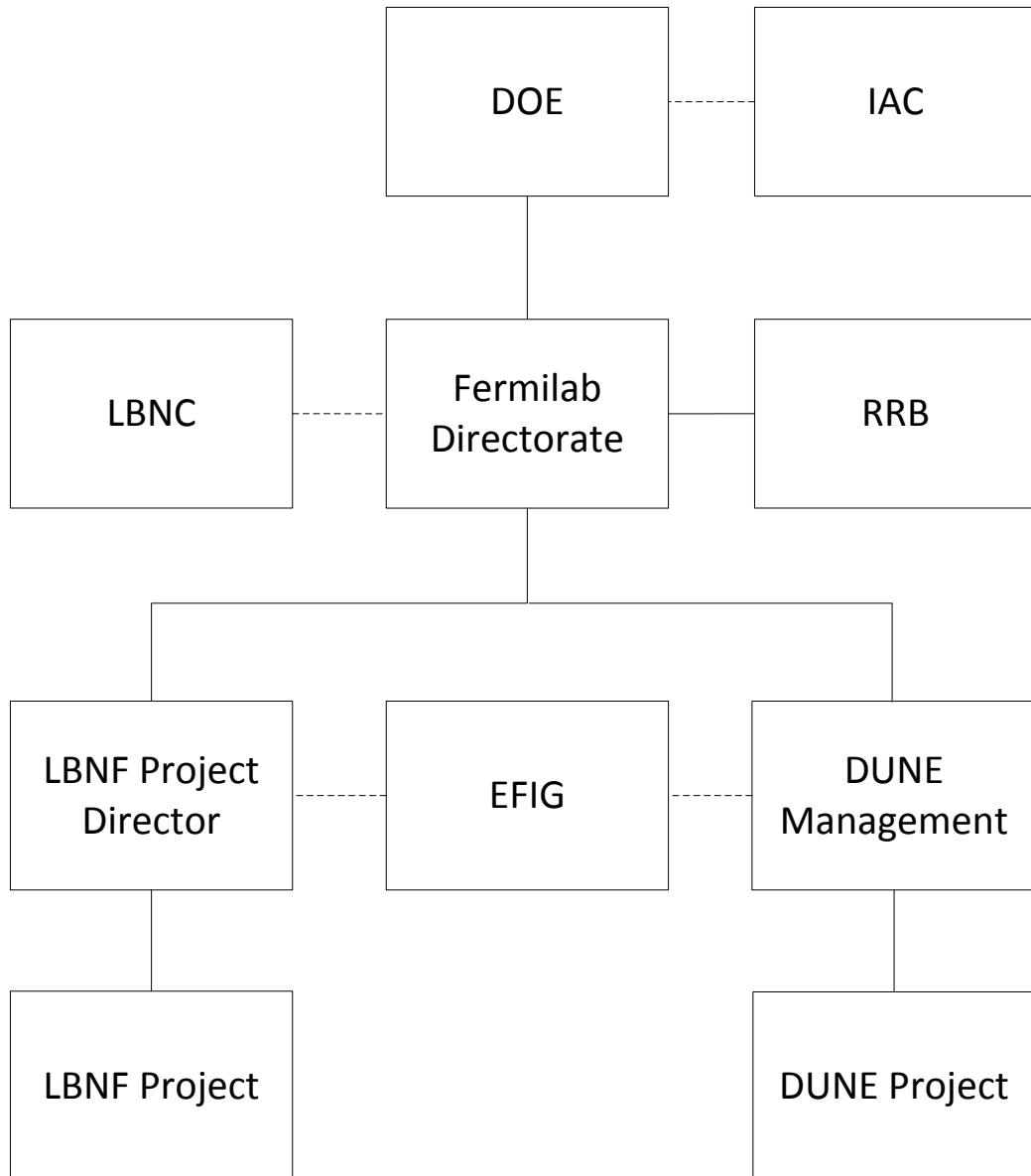


Figure 2.3: Joint LBNF/DUNE management structure

fig:lbnf

## **2.5.1 International Advisory Council (IAC)**

The International Advisory Council (IAC) is composed of regional representatives, such as CERN, and representatives of funding agencies that make major contributions to LBNF infrastructure or to DUNE. The IAC acts as the highest-level international advisory body to the U.S. DOE and the FNAL Directorate, and facilitates high-level global coordination across the entire enterprise (LBNF and DUNE). The IAC is chaired by the DOE Office of Science Associate Director for High Energy Physics and includes the FNAL Director in its membership. The council meets as needed and provides pertinent advice to LBNF and DUNE through the Fermilab Director.

Specific responsibilities of the IAC include, but are not limited to, the following:

- During the formative stages of LBNF and DUNE the IAC helps to coordinate the sharing of responsibilities among the agencies for the construction of LBNF and DUNE. Individual agency responsibilities for LBNF will be established in bilateral international agreements with the DOE. Agency contributions to DUNE will be formalized through separate agreements.
- The IAC assists in resolving issues, especially those that cannot be resolved at the Resources Review Boards (RRB) level, e.g., issues that require substantial redistributions of responsibilities among the funding agencies.
- The IAC assists as needed in the coordination, synthesis and evaluation of input from Project reports charged by individual funding agencies, LBNF and DUNE Project management, and/or the IAC itself, leading to recommendations for action by the managing bodies.

The DUNE Co-Spokespersons and/or other participants within the Fermilab neutrino program will be invited to sessions of the IAC as needed. Council membership may increase as additional funding agencies from

## **2.5.2 Resources Review Boards (RRB)**

The Resources Review Boards (RRB) are composed of representatives from all funding agencies that sponsor LBNF and DUNE, and from the Fermilab management. The RRB provides focused monitoring and detailed oversight of each of the Projects. The Fermilab Director in coordination with the DUNE RC defines its membership. A representative from the Fermilab Directorate chairs the boards and organizes regular meetings to ensure the flow of resources needed for the smooth progress of the enterprise and for its successful completion.

The managements of the DUNE Collaboration and the LBNF Project participate in the RRB meetings and make regular reports to the RRB on technical, managerial, financial and administrative matters, as well as on status and progress of the DUNE Collaboration. DUNE Finance Board members who serve as National Contacts from the sponsoring funding agencies will be invited to RRB sessions.

1 Two groups exist within the RRB: RRB-LBNF and RRB-DUNE. Each of these groups monitors  
2 progress and addresses the issues specific to its area while the whole RRB deals with matters that  
3 concern the entire enterprise. The RRB meet biannually; these meetings start with a plenary  
4 opening session and are followed by RRB-LBNF and RRB-DUNE sessions. As DUNE progresses  
5 toward experimental operations, RRB-Computing sessions will convene.

6 The RRB employs standing DUNE and LBNF *Scrutiny Groups* as needed to assist in its responsi-  
7 bilities. The scrutiny groups operate under the RRB, and provide detailed information on financial  
8 and personnel resources, costing, and other elements under the purview of the RRB.

9 Responsibilities of the RRB include

10 • assisting the DOE and the FNAL Directorate, with coordinating and developing any required  
11 international agreements between partners

12 • monitoring and overseeing the Common Projects and the use of the Common Funds

13      where are these defined?

14 • monitoring and overseeing general financial and personnel support

15 • assisting the DOE and the FNAL Directorate with resolving issues that may require reallo-  
16 cation of responsibilities among the Project's funding agencies

17 • reaching consensus on a maintenance and operation procedure, and monitoring its function

18 • approving the annual Common Fund budget of DUNE for construction and for maintenance  
19 and operation

### 20 **2.5.3 Fermilab, the Host Laboratory**

21 As the host laboratory, Fermilab has a direct responsibility for the design, construction, commis-  
22 sioning and operation of the facilities and infrastructure (i.e., LBNF) that support the science  
23 program. In this capacity, Fermilab reports directly to the DOE through the Fermilab Site Office  
24 (FSO). Fermilab also has an important oversight role for the DUNE Project itself as well as an  
25 important coordination role in ensuring that interfaces between the two Projects are completely  
26 understood.

27 Fermilab's oversight of the DUNE Collaboration and detector construction project is carried out  
28 through

29 • regular meetings with the Collaboration leadership

30 • approving the selection of Collaboration spokespersons

- 1     • providing the Technical and Resource Coordinators
- 2     • convening and chairing the Resources Review Boards
- 3     • regular scientific reviews by the Physics Advisory Committee (PAC) and Long-Baseline Neu-
- 4         trino Committee (LBNC)
- 5     • Director's Reviews of specific management, technical, cost and schedule aspects of the de-
- 6         tector construction project
- 7     • other reviews as needed

#### 8     **2.5.4 DUNE Collaboration**

9     The Collaboration, in consultation with the Fermilab Director, is responsible for forming the  
10    international DUNE Project team responsible for designing and constructing the detectors. The  
11    Technical Coordinator (TC) and Resource Coordinator (RC) serve as the lead managers of this  
12    international project team and are selected jointly by the spokespersons and the Fermilab Director.  
13    Because the international DUNE Project incorporates contributions from a number of different  
14    funding agencies, it is responsible for satisfying individual tracking and reporting requirements  
15    associated with the different contributions.

#### 16    **2.5.5 Long-Baseline Neutrino Committee (LBNC)**

17    The Long-Baseline Neutrino Committee (LBNC), composed of internationally prominent scientists  
18    with relevant expertise, provides external scientific peer review for LBNF and DUNE regularly.  
19    The LBNC reviews the scientific, technical and managerial decisions and preparations for the  
20    neutrino program. It acts in effect as an adjunct to the Fermilab Physics Advisory Committee  
21    (PAC), meeting on a more frequent basis than the PAC. The LBNC may employ DUNE and LBNF  
22    Scrutiny Groups for more detailed reports and evaluations. The LBNC members are appointed by  
23    the Fermilab Director.

#### 24    **2.5.6 Experiment-Facility Interface Group (EFIG)**

25    Close and continuous coordination between DUNE and LBNF is required to ensure the success  
26    of the combined enterprise. An Experiment-Facility Interface Group (EFIG) was established in  
27    January 2015 to oversee and ensure the required coordination both during the design/construction  
28    and operational phases of the program. This group covers areas including:

- 29     • interface between the near and far detectors and the corresponding conventional facilities

- 1     ● interface between the detector systems provided by DUNE and the technical infrastructure
  - 2         provided by LBNF
  - 3     ● design and operation of the LBNF neutrino beamline
- 4     The EFIG is chaired by the two deputy directors of Fermilab. Its membership includes the LBNF  
5     Project Director and Project Manager, and the DUNE Co-Spokespersons, Technical Coordinator,  
6     Resource Coordinator and the CERN-LBNF Project Manager. In consultation with the DUNE  
7     and LBNF management, the EFIG Chairs will extend the membership as needed to carry out the  
8     coordination function. In addition, the DOE Federal Project Director for LBNF, the Fermilab  
9     Chief Project Officer, and a designated representative of the SDSTA will serve ex officio. The  
10    EFIG Chairs designate a Secretary of the EFIG, who keeps minutes of the meetings and performs  
11    other tasks as requested by the Chair.
- 12    It is the responsibility of the EFIG Chairs to report EFIG proceedings to the Fermilab Director and  
13    other stakeholders. It is the responsibility of the DUNE spokespersons to report EFIG proceedings  
14    to the rest of the Collaboration. The EFIG meets weekly or as needed.

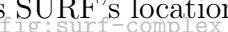
# <sup>1</sup> Chapter 3

## <sup>2</sup> Existing Site Conditions

<sup>3</sup> site-cond  
The SDSTA currently operates and maintains the Sanford Underground Research Facility (SURF)  
<sup>4</sup> at the former Homestake mine in Lead, South Dakota. The SURF property comprises 186 acres  
<sup>5</sup> on the surface and 7,700 acres underground. The SURF Surface Campus includes approximately  
<sup>6</sup> 253,000 gross square feet (gsf) of existing structures. Using a combination of private funds through  
<sup>7</sup> T. Denny Sanford, South Dakota Legislature-appropriated funding, and a federal Department of  
<sup>8</sup> Housing and Urban Development (HUD) Grant, the SDSTA has made significant progress in  
<sup>9</sup> stabilizing and rehabilitating the SURF facility to provide for safe access and prepare the site for  
<sup>10</sup> new laboratory construction. These efforts have included dewatering of the underground facility  
<sup>11</sup> and mitigating and reducing risks

<sup>12</sup> beyond those identified in the (year) assessment of the existing facility conditions done for  
(this needs some context)

<sup>13</sup> the former Deep Underground Science and Engineering Laboratory (DUSEL).

<sup>14</sup>  Figure 3.1 shows SURF's location within the region as a part of the northern Black Hills of South  
<sup>15</sup>  Dakota. Figure 3.2 outlines the SURF site in relationship to the city of Lead, South Dakota, and  
<sup>16</sup> points out various significant features of Lead including the surrounding property that still remains  
<sup>17</sup> under the ownership of Barrick Gold Corporation.

<sup>18</sup> ...who owned and operated the Homestake Mine on the site until (whatever year)? (this needs  
context)

### <sup>19</sup> 3.1 Existing Site Conditions Evaluation

<sup>20</sup> The facility conditions as of

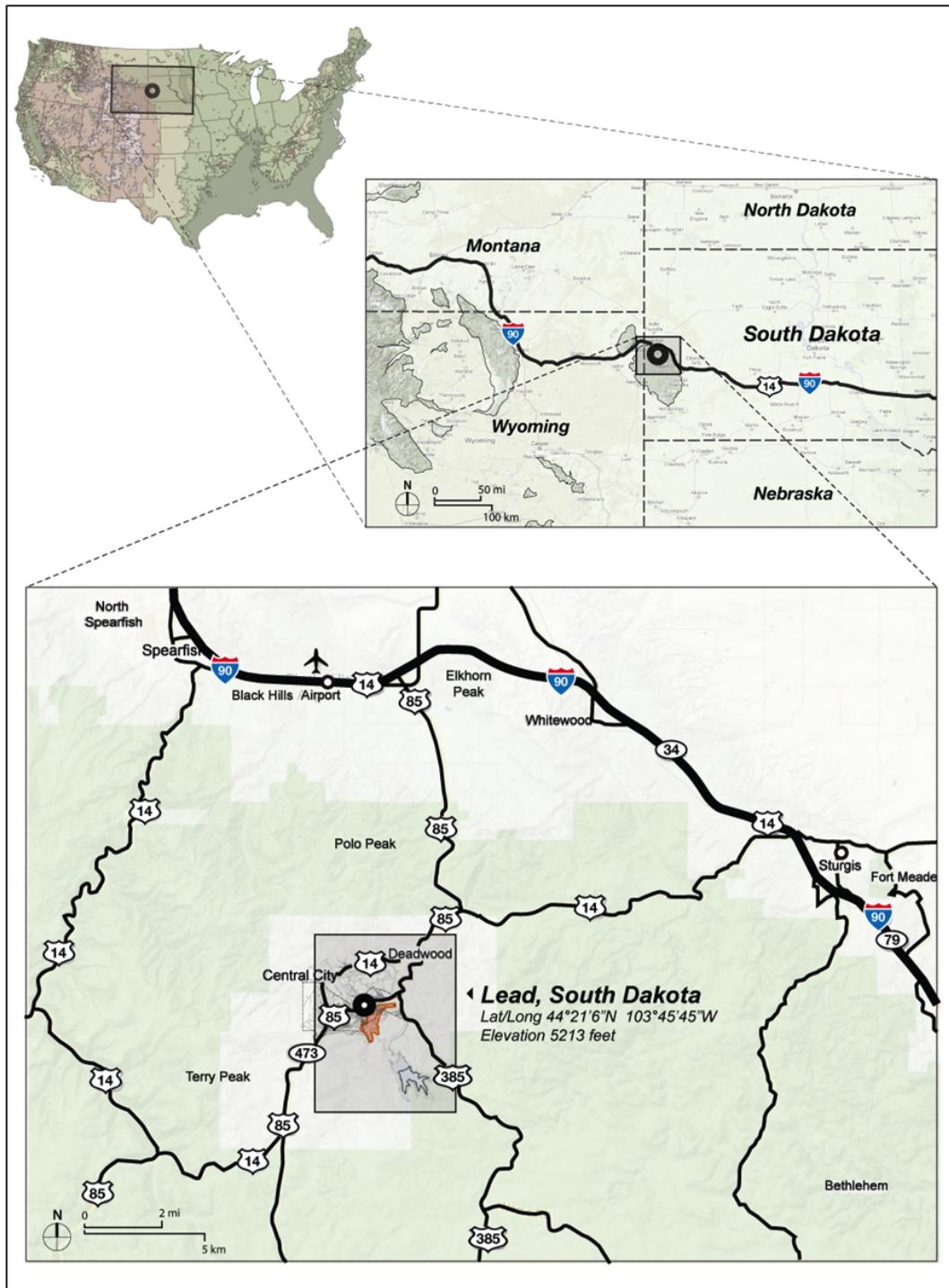


Figure 3.1: Regional context showing the city of Lead, South Dakota. (Dangermond Keane Architecture, Courtesy SURF)

fig:regi

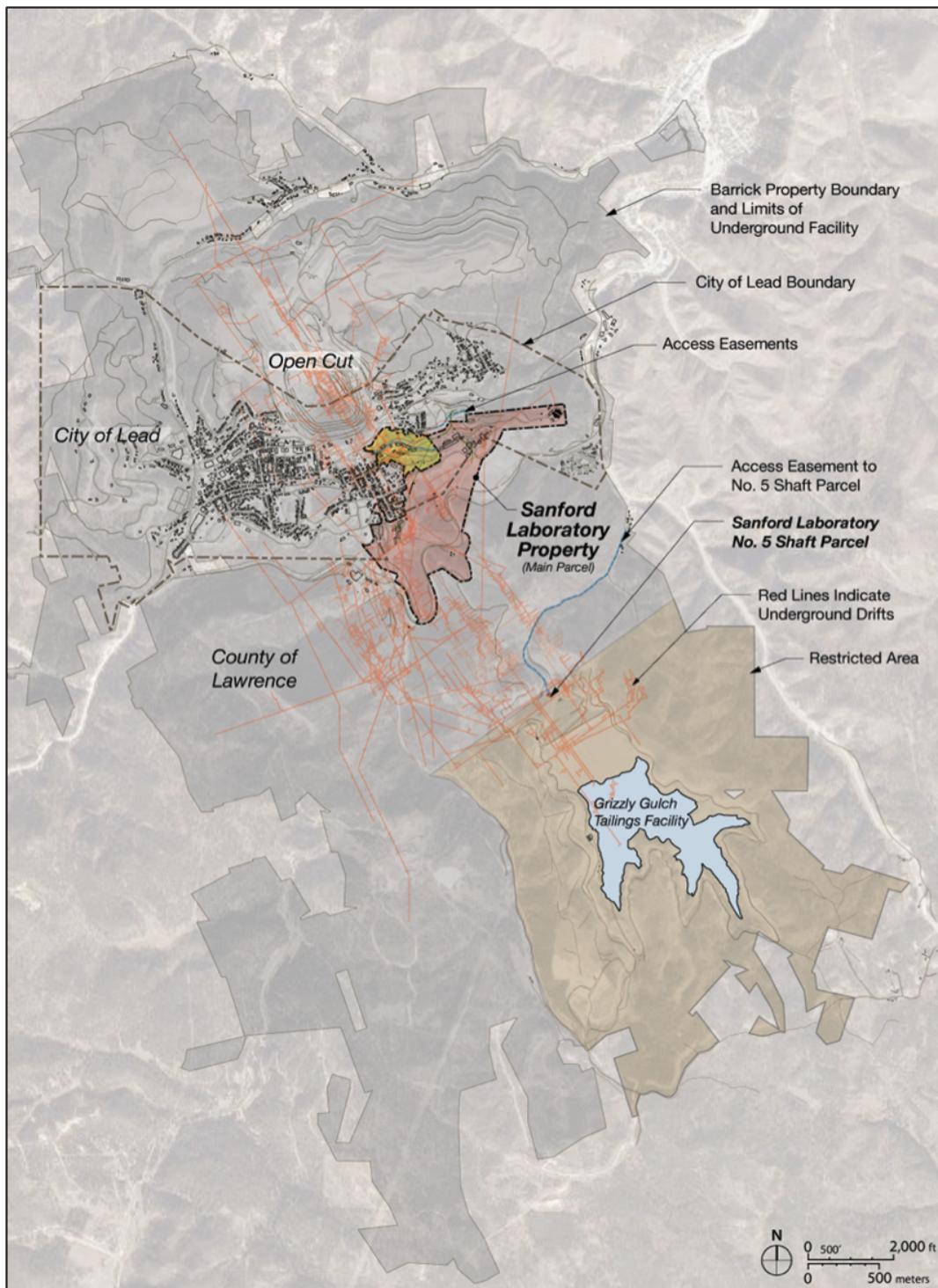


Figure 3.2: SURF Complex shown in the context of the city of Lead, South Dakota, and the property remaining under ownership of Barrick. Area shown in yellow is a potential future expansion of the SDSTA property. [Dangermond Keane Architecture, Courtesy of SURF]

fig:surf

1 year

2 were assessed by HDR

3 who is HDR?

4 as part of the DUSEL Preliminary Design to evaluate the condition of existing facilities and  
5 structures on the Yates, and Ross Campuses. They are documented in the DUSEL PDR, Section  
6 5.2.4, [10]

7 citation

8 . The portions of DUSEL's assessment pertinent to the LBNF Project are included here; they  
9 have been edited to reflect current activities and conditions. References to the DUSEL Project are  
10 from that time, and are now considered historic.

11 The HDR assessments reviewed the condition of buildings that were proposed for continued use  
12 in their then-current function, new use, or potential demolition. Assessments for buildings were  
13 performed on their architectural, structural, mechanical/electrical/plumbing (MEP), civil, envi-  
14 ronmental, and historic aspects. Site assessments looked at civil, landscape, environmental, and  
15 historic aspects. Facility-wide utilities such as electrical, steam distribution lines, water and sewer  
16 systems were also assessed. In particular:

- 17 • Buildings proposed for reuse were evaluated for preliminary architectural and full structural,  
18 environmental, and historic assessments.

19 you evaluate for an assessment? Not clear what you want to say here. 'evaluated or as-  
sessed with regard to these aspects'? 'given a preliminary evaluation to see if they're  
ready for an assessment'? I'm confused (same comment next bullet)

- 20 • Buildings proposed for demolition were evaluated for preliminary historic assessments.
- 21 • Preliminary MEP assessments were performed on the Ross Substation, #5 Shaft fan, Oro  
22 Hondo fan, Oro Hondo substation, and on the general site utilities for the Ross, Yates, and  
23 Ellison Campuses.
- 24 • The waste water treatment plant (WWTP) received preliminary architectural and structural  
25 assessments and a full MEP assessment.
- 26 • Preliminary civil assessments of the Kirk Portal site and Kirk to Ross access road were also  
27 completed.

28 The assessment was completed in three phases and the detailed reports are included in the appen-  
29 dices of the DUSEL PDR as:

- 1 • Phase I Report, Site Assessment for Surface Facilities and Campus Infrastructure to Support
- 2 Laboratory Construction and Operations (DUSEL PDR Appendix 5.E)
- 3 • Phase II Site and Surface Facility Assessment Project Report (DUSEL PDR Appendix 5.F)
- 4 • Phase II Roof Framing Assessment (DUSEL PDR Appendix 5.G)

## 5 **3.2 Evaluation of Geology and Existing Excavations**

6 The accessible underground mine workings at SURF within the footprint of the former Homestake  
7 Gold Mine are extensive. Over the life of the gold mine, over 360 miles of drifts (tunnels) were  
8 mined, and shafts and winzes were sunk to gain access to depths in excess of 8,000 feet. A number  
9 of underground workings are being refurbished by SURF, and new experiments are being installed  
10 at the 4850L, the same level as proposed for the LBNF underground facilities. Geotechnical  
11 investigations and initial geotechnical analyses were completed by Arup, USA

12 cite

13 for the DUSEL Preliminary Design and are described in detail in the DUSEL PDR. Additional  
14 geotechnical investigation and analyses were performed, also by Arup, in 2014 specific to LBNF.  
15 This section provides summaries of these two efforts, including work completed for DUSEL that is  
16 applicable to LBNF (the text is excerpted from the DUSEL Preliminary Design Report, Chapter 5  
17 Section 3). Much of the work completed for the alternative detector technology considered during  
18 the DUSEL timeframe, a water Cherenkov detector (WCD), is also applicable to the current LBNF  
19 design at the 4850L.

### 20 **3.2.1 Geologic Setting**

21 SURF is sited within a metamorphic complex containing the Poorman, Homestake, Ellison and  
22 Northwestern Formations (oldest to youngest), which are sedimentary and volcanic in origin. An  
23 amphibolite unit (Yates Member) is present within the lower known portions of the Poorman  
24 Formation. The LBNF caverns have been located in the Poorman formation to isolate them from  
25 the remainder of the level. The layout adopted on the 4850L attempts to optimize the needs for  
26 ventilation isolation, access control, and orientation relative to the beamline.

### 27 **3.2.2 Rock Mass Characteristics: LBNF**

28 Following a similar strategy as DUSEL, LBNF initiated a second geotechnical program in 2013 to  
29 evaluate the specific location under consideration and evaluate its appropriateness for the proposed  
30 design. This was undertaken in two phases. The first phase was a mapping of the existing spaces

1 surrounding the proposed rock mass using both visual techniques and laser scanning to understand  
2 the rock mass and to inform the scope of the second phase. The second phase included drilling  
3 of four HQ (2.5-in diameter) core holes ranging in length from 477 to 801 feet as well as two 6-in  
4 diameter core holes ~30 ft each. The smaller diameter cores were then evaluated for the following  
5 characteristics:

- 6     • core recovery percent  
7     • rock quality designation (RQD) percent  
8     • rock type, including color, texture, degree of weathering, and strength  
9     • mineralogy and presence of magnetic sulfides  
10    • character of discontinuities, joint spacing, orientation, aperture  
11    • roughness, alteration, and infill (if applicable)

12 Representative samples were selected from the overall core to test material strength and chemi-  
13 cal characteristics. The [fig:core-loc](#) geotechnical site investigations area on the 4850L, showing boreholes is  
14 presented in Figure 3.3.

15 The holes from which the smaller diameter core was removed were studied in several ways. An  
16 absolute survey was conducted to allow the core holes to be plotted relative to cavern designs. An  
17 optical televiewer was passed through each small hole to visualize the rock mass. This technique  
18 allows visualization of foliation, joint openings, healed joints, and geological contact between rock  
19 types. An acoustical imaging device was also used in one hole to complement the optical informa-  
20 tion. The permeability of the rock was tested by pressurizing the small holes at various intervals to  
21 determine whether joints allowed for the flow of water outside of the holes (hydraulic conductivity).  
22 In all cases, the hydraulic conductivity was well below what can be accomplished using manmade  
23 techniques such as grouting. Two of the small holes were plugged and instrumented to determine  
24 whether water would flow into the holes over time. This test found very low flow rates (.0013 –  
25 .0087 gpm). Ongoing evaluation of pressure build in these holes was inconclusive, as blast-induced  
26 fracturing near the existing drifts allow the holes to depressurize outside of the

27 range of the?

28 test instruments.

29 The larger (6-in) diameter cores and holes were used for strength and stress testing. In situ stress  
30 was tested by drilling a smaller diameter hole first, then gluing a strain gauge at 30 – 36 feet within  
31 the depth. As the larger diameter core was removed, this strain gauge recorded the relaxation of the  
32 rock. The removed core was re-drilled to provide smaller diameter samples at specific orientations  
33 for strength testing, as the strength of the material varies based on applied force direction relative  
34 to the foliation of the rock. These samples were also tested for time-dependent movement.

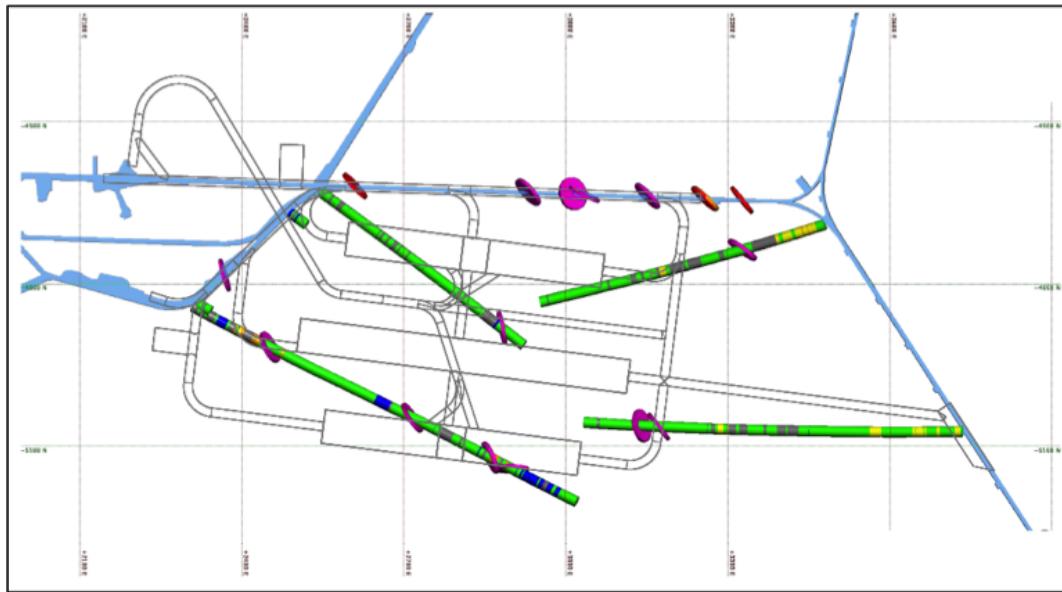


Figure 3.3: LBNF core locations and geological features

fig:core

1 LBNF reviewed the analysis performed by Arup by enlisting industry leaders as part of a Neutrino  
2 Cavity Advisory Board (NCAB). This board reviewed the approach and results of the geotechnical  
3 investigation program as well as the preliminary excavation design. Their conclusions indicated  
4 that no additional drilling would be required to provide design information for the project and the  
5 overall design approach was appropriate. The board provided many recommendations that will  
6 advance the design, for example, replacement of wire mesh with fiber-reinforced shotcrete in all  
7 excavations, reduction of the distance between caverns, and optimization of the ground support  
8 aimed at replacing cable support wherever possible.

9 For further details, see Arup's Geotechnical Interpretive Report [11].

10 citation

### 11 3.2.3 Geologic Conclusions

12 Recovery of rock cores was performed along with geologic mapping to determine if discontinuities  
13 in the rock mass exist that could cause difficulties in the excavation and maintenance of the planned  
14 caverns. In general, the proposed locations of the excavations appear to be free of problematic  
15 structures. This information, along with measurement of in situ stresses, has allowed numerical  
16 modeling of the stresses associated with the anticipated excavations. A sample of some of the  
17 initial modeling is provided in Figure 3.4.

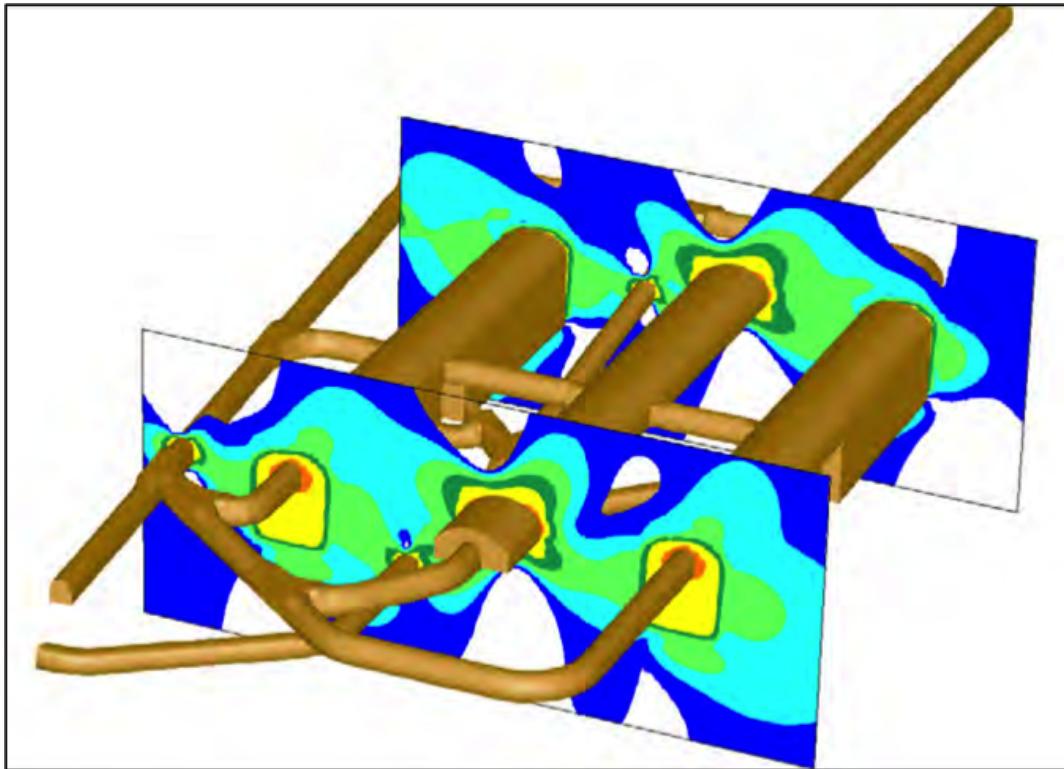


Figure 3.4: Contour of stress safety factor indicating influences between caverns

fig:cont

# <sup>1</sup> Chapter 4

## <sup>2</sup> Surface Facility

### <sup>3</sup> 4.1 Existing Surface Facility

<sup>4</sup> The SURF property of 186 acres includes steep terrain and man-made cuts dating from its mining  
<sup>5</sup> history. There are approximately 50 buildings and associated site infrastructure in various states  
<sup>6</sup> of repair.

<sup>7</sup> Need a sentence saying something about why ross complex is important, to lead into next sentence, e.g., “the FSCF is located in the Ross Complex”

<sup>8</sup> A select few of these buildings at the Ross Complex will be upgraded and rehabilitated as necessary  
<sup>9</sup> for use by LBNF, as will the main utilities. A layout of the overall SURF architectural site plan  
<sup>10</sup> for the LBNF Project is found in Figure 4.1.

<sup>11</sup> The Ross Complex will house the facility construction operations, the Command and Control  
<sup>12</sup> Center for the experiment and facility and a new Cryogenics Compressor building, and will continue  
<sup>13</sup> to house the SURF maintenance and operations functions. Layout of the surface facilities in the  
<sup>14</sup> vicinity of the Ross Shaft is shown in Figure 4.2.

### <sup>15</sup> 4.2 Surface Buildings

<sup>16</sup> Surface buildings for LBNF, existing and planned, include those necessary for safe access and  
<sup>17</sup> egress to the underground through the Ross Shaft and for office space. The existing buildings will  
<sup>18</sup> be rehabilitated to comply to codes and to the experiment’s requirements. The Ross Dry building  
<sup>19</sup> will be modified to provide space for a surface control room (the Command and Control Center)  
<sup>20</sup> and offices. The description in this section is excerpted from the 100% Preliminary Design Report

<sup>21</sup>

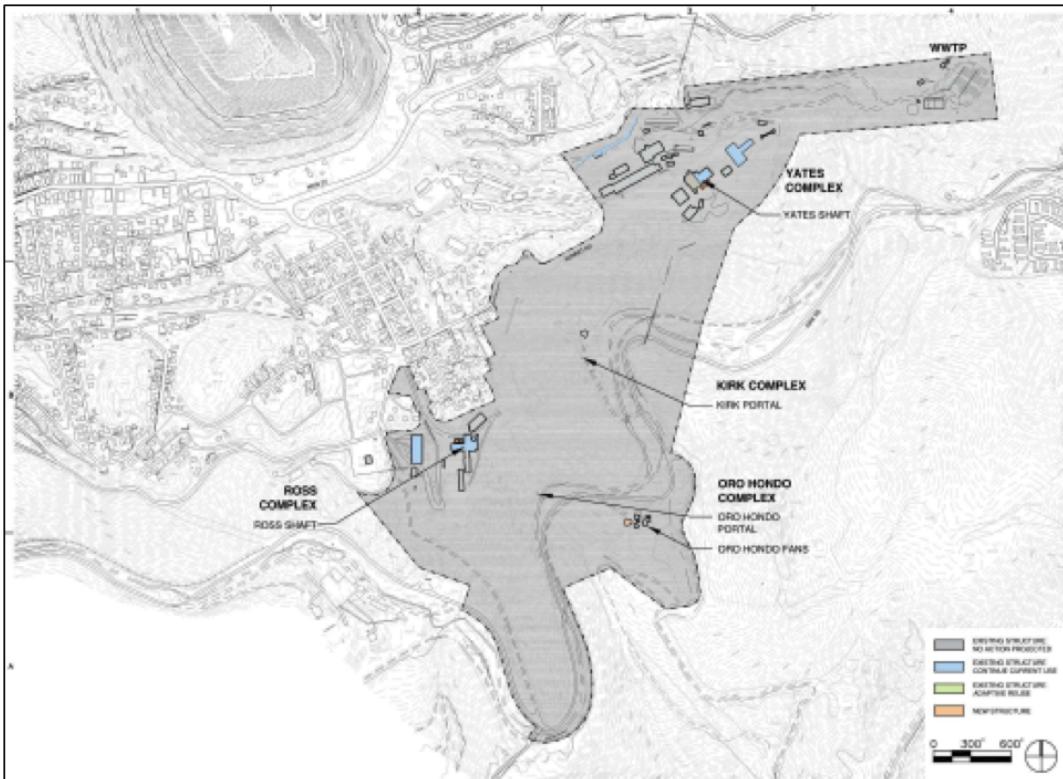


Figure 4.1: Architectural site plan (HDR)

add north pointing arrow

image fuzzy; orig available?

fig:arch

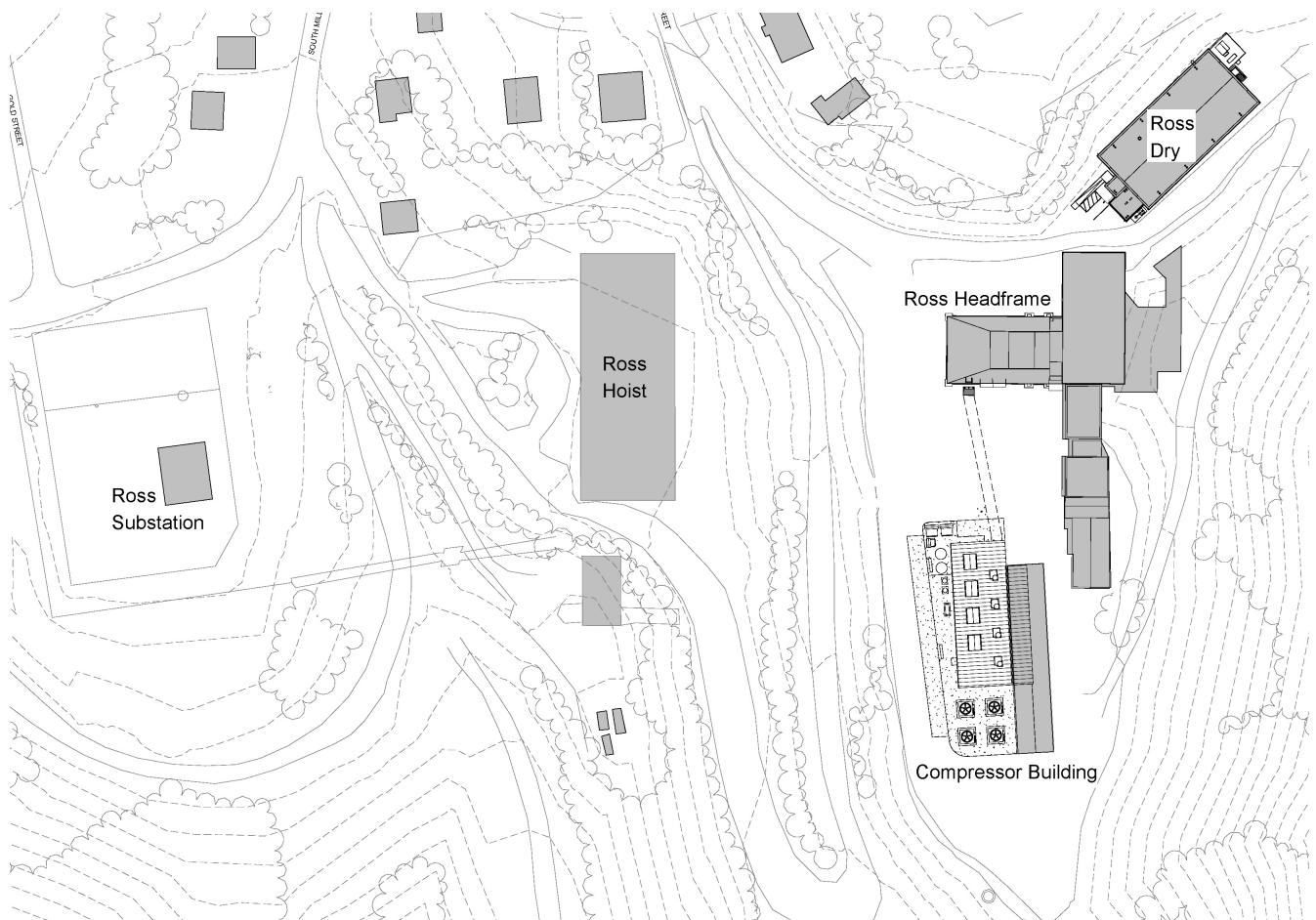


Figure 4.2: Ross Complex architectural site plan (Arup)

fig:ross

1 cite

2 provided by Arup, USA.

3 A new building and surrounding concrete slabs are planned in order to provide space for the equipment required for conversion of liquid argon and liquid nitrogen to gaseous form and compression of the nitrogen gas for delivery through the shaft to the underground. The location of this building was selected based on proximity to the shaft and accessibility for trucks, as thousands of truckloads of argon will be required to fill the detectors underground.

8 In addition to housing

9 supporting?

10 nitrogen compressors inside the building, concrete slabs will be placed around the building for installation of argon and nitrogen receiving dewars (into which the trucks will unload), vaporizers to boil the liquids into gas, an electrical transformer to supply power to the four 1,500-Hp compressors, a standby generator, and cooling towers to reject heat generated through compression. All equipment except the cooling towers and associated circulation pumps is provided by the LBNF Cryogenics Infrastructure

16 reference cryo design doc

17 . The architectural layout of this building and surrounding equipment is provided in Figure 4.3. fig:compressor-l

18 With all this description of concrete slabs, they should be labeled in the figure

### 19 4.2.1 Ross Dry Building

-rossdry  
20 The Ross Dry building is in use by SURF to provide office and meeting space in addition to men's and women's dry facilities

22 explain or replace 'dry facilities'

23 and emergency response capabilities. As a scope option, the design includes a complete renovation of this building to upgrade these existing capabilities and to add space for an above-ground Control and Command Center. (This control center itself is not a scope option; it could be placed in a different location.) This design includes flexible space that can be tailored to evolving needs as the project transitions from construction to operations.

28 The exterior of the Ross Dry Building is shown in Figure 4.4. The proposed renovations are shown in Figures 4.5 and 4.6. fig:ross-dry-ext  
fig:cmd-togtmd-center-maintainer-basement

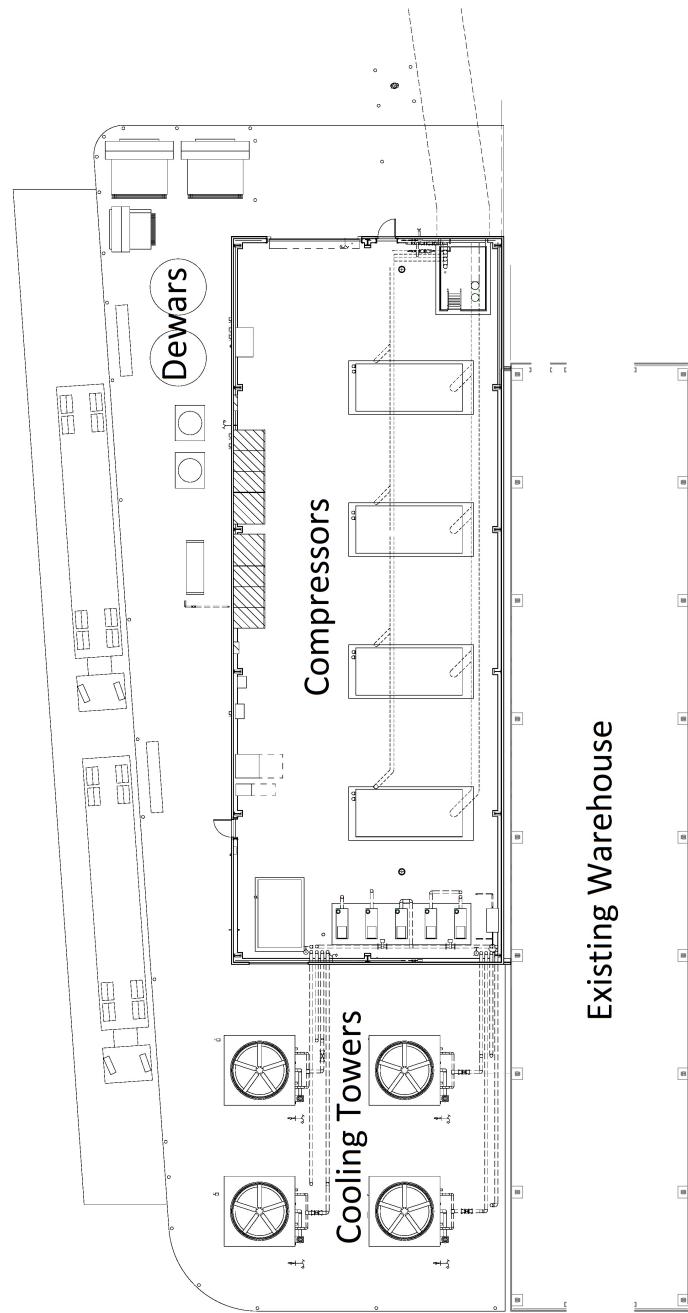


Figure 4.3: Architectural layout of LBNF Cryogenics Compressor Building

fig:comp



Figure 4.4: Photo of Ross Dry exterior (HDR)

Need orig; too fuzzy

fig:ross

## 4.2.2 Ross Headframe and Hoist Buildings

- 1 The Ross Headframe Building will be the main entry point for construction activities and for  
2 ongoing operations and maintenance functions. In addition, gas pipes from the LBNF Cryogenics  
3 Compressor Building will pass through this building on the way to the shaft.  
4  
5 Following shaft rehabilitation, the LBNF Project will include structural reinforcement of the Ross  
6 Headframe to meet current codes and standards. The headframe will also be modified to accom-  
7 modate loads with dimensions longer than it can currently accommodate. This project will occur  
8 concurrently with other site preparation activities planned to be performed outside of the CD-3a  
9 scope, as described in Chapter ??.

10 Not a word about the hoist building; change subsection title?

## 4.2.3 Yates Headframe Building

- 11 The Yates Shaft, which terminates in the headframe building at the Yates Campus, will be  
12 used for delivery of personnel and materials underground during construction and operation of  
13 LBNF/DUNE. The building and shaft will in fact be critical to LBNF during the installation of  
14 gas piping through the Ross Shaft, during which time the Ross Shaft will be restricted to that  
15

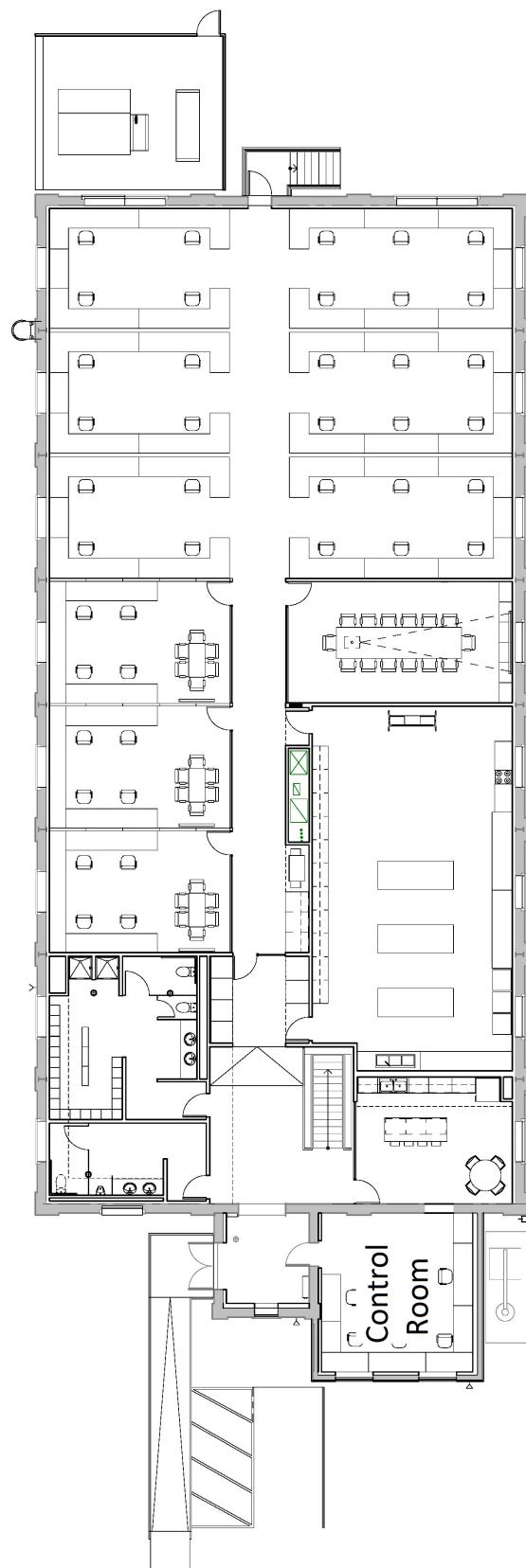


Figure 4.5: Ross Dry Building renovation, main floor, showing the planned location for the control room (Command and Control Center).

fig:cmd-

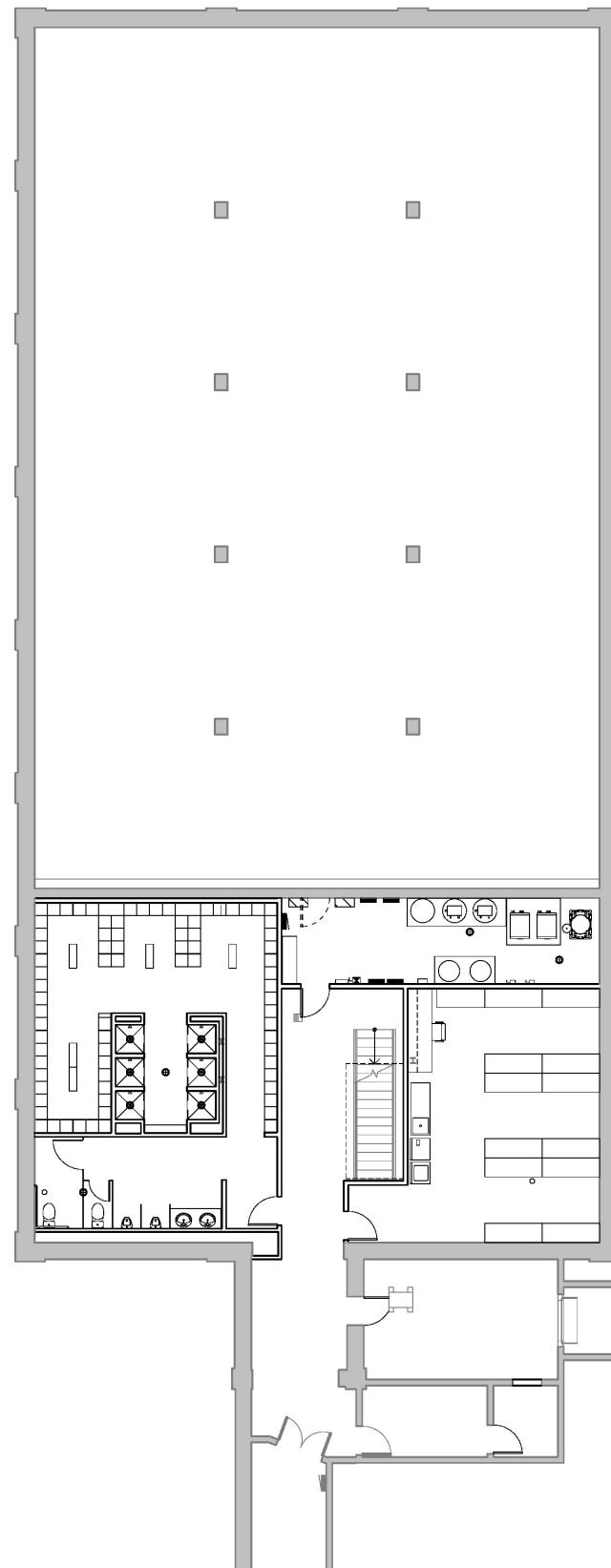


Figure 4.6: Ross Dry Building renovation, basement.

fig:cmd-

1 activity plus emergency egress. The LBNF Project will therefore include structural reinforcement  
2 of the Yates Headframe to meet current codes and standards, to be completed prior to the in-  
3 stallation of gas piping through the Ross shaft. Installation of a redundant fiber optic backbone  
4 through the Yates Shaft is reserved as a LBNF scope option.

5 a word on why it's necessary or beneficial?

#### 6 **4.2.4 Ross Crusher Building**

7 The existing Ross Crusher Building is a high-bay space that contains rock-crushing equipment  
8 used for construction operations. The exterior of the building will be repaired

9 rehabilitated?

10 to create a warm, usable shell.

11 because it's not heated now? Is this so that people can work in it?

12 The upgrade of the existing crusher equipment is part of the waste rock handling work scope (see  
13 Section ??) and not part of the building rehabilitation.

### 14 **4.3 New Surface Infrastructure**

15 Surface infrastructure includes items such as retaining walls and parking lots, as well as utilities  
16 to service both buildings and underground areas.

17 much of the?

18 Existing infrastructure requires both rehabilitation and upgrades to meet code and LBNF require-  
19 ments.

20 this is on project?

21 No new roads or parking lots are required for LBNF at SURF. However, the Ross Complex site  
22 will require minor demolition

23 'minor demolition'? sounds like an oxymoron

24 of power lines and a fire hydrant that are no longer used in order to provide adequate accessibility

- <sup>1</sup> for truck traffic to the new Cryogenics Compressor Building. An existing space will be designated
- <sup>2</sup> for handicap parking adjacent to the Ross Dry Building. Additional road work is required for
- <sup>3</sup> truck transportation of waste rock, as described in the waste rock handling section.

<sup>4</sup> ref

# 1 References

- 2 [1] LBNF/DUNE, “LBNF/DUNE Conceptual Design Report (CDR),” tech. rep., 2015. DUNE  
3 Doc 180-183.
- 4 [2] Particle Physics Project Prioritization Panel, “Building for Discovery; Strategic Plan for U.S.  
5 Particle Physics in the Global Context,” 2014. [http://science.energy.gov/~/media/hep/hepap/pdf/May%202014/FINAL\\_P5\\_Report\\_Interactive\\_060214.pdf](http://science.energy.gov/~/media/hep/hepap/pdf/May%202014/FINAL_P5_Report_Interactive_060214.pdf).
- 7 [3] CERN Council, “The European Strategy for Particle Physics, Update 2013,” 2013. <http://council.web.cern.ch/council/en/EuropeanStrategy/ESParticlePhysics.html>.
- 9 [4] LBNF/DUNE, “LBNF/DUNE Science Requirements,” tech. rep., 2015. DUNE Doc 112.
- 10 [5] Arup, “LBNF FSCF 100% Preliminary Design Report ,” tech. rep., 2015. DUNE Doc 136.
- 11 [6] LBNF/DUNE, “Design Report: The LBNF and DUNE Projects,” tech. rep., 2015. DUNE  
12 Doc ???
- 13 [7] D. Collaboration, “DUNE/LBNF CDR Volume 2: The Physics Program for DUNE at LBNF,”  
14 tech. rep., 2015. DUNE Doc 181.
- 15 [8] L. Project, “Design Report: The Long-Baseline Neutrino Facility for DUNE,” tech. rep., 2015.  
16 DUNE Doc ???
- 17 [9] D. Collaboration, “DUNE/LBNF CDR Volume 4: The DUNE Detectors at LBNF,” tech.  
18 rep., 2015. DUNE Doc 183.
- 19 [10] LBNF, “LBNF Draft Comprehensive Logistics Report,” tech. rep., 2015. DUNE Doc 423.