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**RECORD OF REVISIONS**

Rev	Date	Description	POC	OIC
0	6/28/99	Revised to become Chapter 3 of Facility Engineering Manual (FEM), superseding Civil Facilities Engineering Standards, Volume 3, Revision No. 8, 6/5/98.	Edward J. Hoth, <i>FWO-UI</i>	Dennis McLain <i>FWO-FE</i>
1	8/16/04	Chapter divided into four sections based on UniFormat. Complete text revision. FEM now ESM.	Edward J. Hoth, <i>FWO-UI</i>	Gurinder Grewal <i>FWO-DO</i>
2	10/27/06	Administrative changes only. Organization and contract reference updates from LANS transition. IMP and ISD number changes based on new	Edward J. Hoth <i>MSS-UI</i>	Kirk Christensen, <i>CENG</i>

		Conduct of Engineering IMP 341. Master Spec number/title updates. Other admin changes.		
3	05/27/15	Addition of EISA Section 438 requirements, revised Rainfall-Intensity-Duration Curve, other minor technical and admin updates.	Jerome Gonzales, <i>ES-UI</i>	Larry Goen, <i>ES-DO</i>

**CONTACT THE CIVIL ENGINEERING STANDARDS POC**

for upkeep, interpretation, and variance issues

<b>Ch. 3, G20</b>	<a href="#"><u>Civil POC/Committee</u></a>
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## G20 SITE IMPROVEMENTS

### G20GEN

#### 1.0 HYDROLOGICAL ANALYSES

- A. Perform hydrologic analyses prior to design of drainage within LANL boundaries. Use appropriate industry standard methodologies such as the Rational Method, Technical Release 55, SWMM, and HEC methodology to compute peak flows from drainage areas and for sizing drainage structures. Unless conditions or requirements dictate, the recommendation is to use a 25-year-return storm. Refer to methodologies outlined within the USDA National Resources Conservation Service: [National Engineering Handbook, Part 630, Hydrology](#) in hydrologic analyses for large off-site drainage areas. *Guidance: Refer to [Volume 1-Hydrology 1995](#) of the New Mexico State Highway Department New Mexico Drainage Design Bureau and U.S.D.A. Natural Resources Conservation Service publication [Urban Hydrology for Small Watersheds](#), TR 55 for further guidance.*
- B. Sites disturbing greater than 5,000 square feet are subject to Section 438 of the Federal Energy Independence and Security Act of 2007 which establishes strict storm water runoff requirements for federal facility development and redevelopment projects. The Section reads, “The sponsor of any development or redevelopment project involving a Federal facility with a footprint that exceeds 5,000 square feet shall use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of flow.”

Implementation of Section 438 must be achieved through the use of green infrastructure/low impact development (GI/LID) methods that use or mimic natural processes to: 1) infiltrate and recharge, 2) evapotranspire, and/or 3) harvest and use precipitation near to where it falls to earth. Examples of appropriate GI/LID are:

- green roofs
- trees and tree boxes
- rain gardens
- vegetated swales
- pocket wetlands
- infiltration planters
- porous and permeable pavements
- vegetated strips
- reforestation and revegetation
- protection of riparian buffers and floodplains
- rain barrels and cisterns

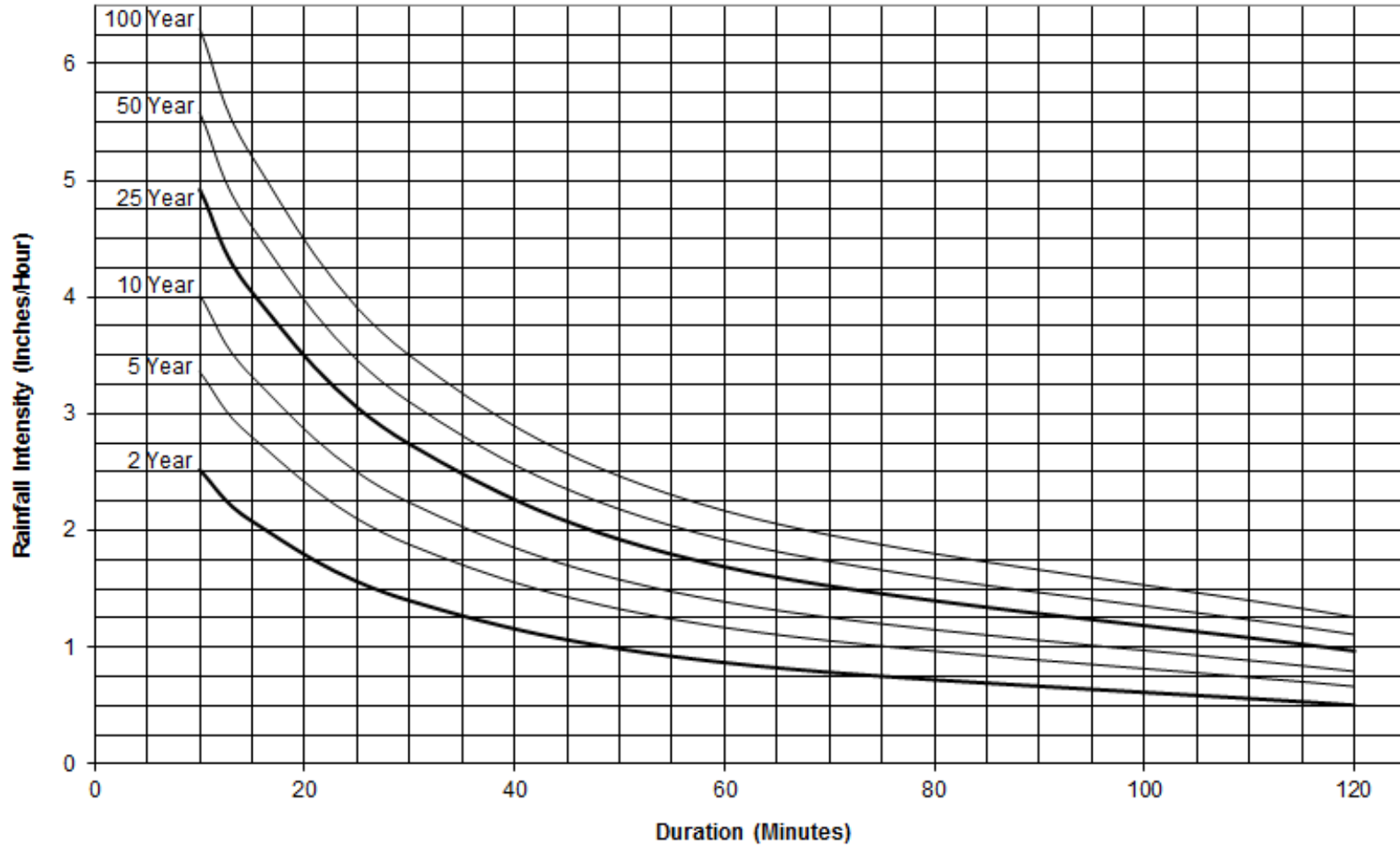
GI/LID features must be sized and constructed to release stormwater runoff at rates and volumes no greater than predevelopment. Pre and post-development runoff hydrology shall be calculated based on a 1.14 inch event (2 year/ 24 hour design storm). A

different precipitation depth based on available site specific rain gage data may be used if prior approval is obtained from ENV-CP and U&IF. Project designs and hydrologic calculations must be reviewed and approved by an ENV-CP. Construction specifications are published in the LANL [Storm Water BMP Manual](#).

*Guidance:*

1. *Site-specific soil properties, such as infiltration rate, may be required for larger projects. Contact [Environmental Compliance Programs](#) (ENV-CP) for guidance.*
  2. *Projects with limited space, poor soil infiltration rates, or other technical constraints may be able to document Technical Infeasibility and manage runoff to the maximum extent technically feasible.*
- C. In accordance with [DOE Standard 1020](#), the potential for flooding shall be considered for LANL sites that are located in defined flood plains. Utilize available information for the evaluation of local flooding potential and surface drainage analysis. For design of facilities subject to flood plain hydrology, use DOE-STD-1020 guidance of a 25-year, 6-hour rainfall event (*latest edition*) for minimum design of surface drainage or water collection management systems.
- D. For the Rational Method, use the Rainfall Intensity-Duration-Relationship Curve (Figure G20GEN-1), and the C-factors in Table G20GEN-1.
- E. Submit hydrologic analyses to the LANL Subcontract Technical Representative (STR) for coordination with ENV-CP and Utilities and Institutional Facilities (U&IF) and the approved analysis to the project file. Drainage submittals should include the following:
1. Drainage area map showing the location of the site in relation to well-known landmarks.
  2. Description of existing and proposed structures, which will influence site drainage.
  3. Hydrologic calculations, including a runoff tabling sheet.

Figure G20GEN-1  
Rainfall Intensity-Duration-Relationship Curve<sup>1</sup>



<sup>1</sup> From ENV-CP data

TABLE G20GEN-1  
C-Factors

Use the following C-factors in conjunction with the Rational Method		
URBAN		
Lawns	Flat 0-2 Percent	.05 - .15
	Average 2-7 Percent	.15 - .25
	Steep >7 Percent	.25 - .35
Roofs		.75 - .95
Business	Downtown	.70 - .95
	Neighborhood	.50 - .70
Industrial		
	Heavy-commercial	.60 - .90
	Light-commercial	.50 - .80
Streets	Asphalt concrete	.70 - .95
	Portland concrete	.80 - .95
	Gravel, shoulders	.40 - .60
Unimproved		.10 - .30

Note: The ranges of C-values presented are typical for return periods of 2-10 years. Higher values are appropriate for larger design storms. Suggested multiplier factors for larger design storms are:

Storm	Multiplier
25-year	1.15
50-year	1.20
100-year	1.25

## 2.0 HYDRAULIC DESIGN

- A. Where possible, use G/LID features to promote infiltration, evapotranspiration or capture and re-use of surface drainage prior to routing to existing storm drainage system (see G20 GEN 1.B above).
- B. Make use of open ditches and install pipe culverts at all walkways (12 in. dia. minimum) and road crossings (24 in. dia. min.). Provide new culverts with appropriate end sections, head walls and erosion-resistant discharge end designs. Comply with AASHTO RSDG, Roadside Design Guide, for clear zone requirements. Provide invert elevations at inlet and discharge end of culverts and percentage of slope for the pipe grade.
- C. Produce hydraulic design calculations, accompanied by preliminary design drawings, submit for approval to the LANL STR for coordination with ENV-CP and U&IF and for review and approval.

- D. Refer to the following for guidance:
1. U.S. Department of Interior, Bureau of Reclamation publications *Design of Small Canal Structures* and *Design of Small Dams* for appropriate design considerations for open channels and other surface drainage facilities.
  2. American Society of Civil Engineers, *Design and Construction of Urban Stormwater Management Systems*, 1993.
  3. FHWA Hydraulics publication HDS 5, *Hydraulic Design of Highway Culverts*.
  4. LANL [Storm Water BMP Manual](#).

### 3.0 CONCRETE STRUCTURE

- A. Construct exterior sidewalks, curbs, gutters, curb ramps, utility pads, drive pads, and all other concrete structures with air-entrained concrete,  $f'c = 4000$  psi. High-early-strength concrete may be required for traffic control purposes. See Master Spec Section [03 3053](#), Miscellaneous Cast-in-Place Concrete.

## G2010 ROADWAYS

### 1.0 ROAD DESIGN

- A. The fundamental approach to road design is to first identify the design speed the road is to accommodate, the nominal vehicle type that governs the design, and the road classification such as arterial, collector, etc. Design is then accomplished by selection of appropriate characteristics to accommodate the design vehicle at the design speed in a safe and efficient manner at reasonable cost on a durable road. The LANL Traffic Engineer will determine road classification, design speed, and design vehicles for all projects and establish posted legal speeds after appropriate examination of the completed road.
- B. Designs, including temporary traffic control, shall conform to the following:
1. AASHTO GDHS, A policy on Geometric Design of Highways and Streets
  2. AASHTO GBF, Guide for Development of Bicycle Facilities
  3. AASHTO RSDG, Roadside Design Guide
  4. ITE TEH, Traffic Control Engineering Handbook [Institute of Transportation Engineers, [ite.org](http://ite.org)]
  5. MUTCD, Manual on Uniform Traffic Control Devices, latest edition  
<http://mutcd.fhwa.dot.gov/>
  6. *Guidance: Reference LANL Site and Architectural Design Principles (Sect. IV.B and C) and Sustainable Design Guide (Sect 3 pg 44-45), on [Architectural Chapter Webpage](#), for additional expectations.*
- C. Concept and formal design of roadways including geometry, structures, striping, and signage shall be reviewed and approved by the LANL Traffic Engineer.

### 2.0 CLASSIFICATION OF ROADS

- A. Consult with the LANL Traffic Engineer for determination of Functional System Characterization of roadways.

- B. Arterial
  - 1. East Jemez (from Diamond Drive to NM4)
  - 2. West Jemez (from NM4 to Diamond Drive)
  - 3. Pajarito Road (from Diamond Drive to NM4)
  - 4. Diamond Drive (from Los Alamos Canyon Bridge to Pajarito Road)
- C. Collector Roads
  - 1. Pecos Road
  - 2. Anchor Ranch Road
  - 3. La Mesita Road
  - 4. Two Mile Mesa Road
  - 5. Mercury Road
  - 6. R-Site Road
  - 7. Eniwetok Drive
  - 8. TA-22 Connection Road
  - 9. Puye Road
  - 10. Sigma Road
  - 11. Bikini Atoll
  - 12. West Road
  - 13. Pajarito Road (from West Jemez to Diamond Drive)
  - 14. Potrillo Road

### 3.0 GEOMETRIC DESIGN CRITERIA

- A. Comply with the latest AASHTO GDHS, *A Policy on Geometric Design of Highways and Streets*.
- B. The minimum desirable gradient consistent with acceptable drainage is 0.5%. Roads and driveway gradients should not exceed 4%.
- C. Provide a normal crown, as shown in Civil Drawing(s) ST-G2010-1, on internal roads to promote control of drainage and nuisance flows. Due to local terrain and climatic conditions the maximum rate of super elevation shall not exceed 4% within LANL boundaries.
- D. Roadways, driveways, parking lots, and pedestrian facilities shall optimize most available sun exposure for winter months.

### 4.0 DRAINAGE CONSIDERATIONS

- A. Provide, where possible, crown configuration and transitional reaches of pavement surfaces to minimize traffic interference by drainage flows and icing.
- B. Conform to above Subsection “Hydrological Analyses and Hydraulic Design,” for drainage analysis and improvements.
- C. Where possible, use GI/LID features to promote infiltration, evapotranspiration or capture and re-use of surface drainage prior to routing to existing storm drainage system (*G20 GEN 1.B above*)



## 5.0 INTERSECTION DESIGN FOR ROADS WITHIN LANL BOUNDARIES

- A. Provide roads to intersect at right angles as local topography will allow. Where unusual circumstances require the use of acute angles at road intersections, these angles shall not be less than 80 degrees.
- B. Design intersections to pass a WB-50 design vehicle. Radius dimensions shall be determined by speed and geometry.

## 6.0 INTERSECTION GRADING

- A. Intersection grading must provide characteristics consistent with the design speed of the through road. Curb flowline profile projections through intersections will be required for major intersection designs which involve internal collector roads.
  - 1. Minor leg intersection approach tangent gradients shall not exceed 4% for a distance of at least 50 feet back from the projected curb flowline of the through road.
  - 2. Reduce road crowns through the intersections of major roads of approximately equal classification to promote comfort; however, crown reduction should not exceed one half of the standard crown. Intersection grading must provide for rapid drainage. Crown should consider roadway with major flow of traffic to set priority on size.
  - 3. Intersection designs shall provide for clear sight distances design.

## 7.0 PAVEMENT STRUCTURES

- A. Currently acceptable pavement design procedures include the local adaptation of those procedures developed by the New Mexico Department of Transportation entitled Structural Design Guide for Flexible Pavement, NMDOT Bulletin 102.
- B. Acceptable pavement design procedures require investigation and evaluation of subgrade soils and traffic data including estimated percentage of heavy vehicles. Pavement data shall be submitted for review and approval by the LANL Traffic Engineer.
- C. Roadways (pavement structure designs) shall conform to AASHTO HS-20 Highway Loading. Any deviations for HS-20 Highway Loadings must be approved by LANL Utilities & Institutional Facilities Group. Perform subgrade soils investigation and evaluation to determine the bearing values of the proposed subgrade soils.
- D. Submit job-specific pavement designs and mix designs for review and approval by the LANL Traffic Engineer.

## 8.0 PAVEMENT MATERIALS

- A. Comply with the New Mexico Department of Transportation Standard Specifications for Highway and Bridge Construction including their latest modifications (supplemental specifications and special provisions).
- B. Roadway asphalt paving and parking lot paving shall consist of a minimum of 4 inches of a plant-produced hot-mix asphalt (HMA) on top of a minimum of 8 inches of aggregate base course on a prepared subbase.

- C. Portland Cement Concrete Pavement: Use design criteria outlined within the New Mexico Department of Transportation Standard Specifications in the structural design of Portland Cement concrete pavements.
- D. Pavement markings be included and appropriate signs shall be installed.
- E. Refer to Civil Standard Detail [ST-G2010-1](#), Typical Road and Parking Lot Sections; and LANL Master Specification [32 1216](#), Asphalt Paving.

## 9.0 CURB AND GUTTER

- A. Provide 6-inch-high, barrier-type curb and gutter with 1-1/2 inch gutter depth for standard section. Use this curb and gutter section for all internal corridors, collectors, and internal roads within LANL boundaries. Reverse outflow gutter shall be used only with approval of LANL U&IF Group.
- B. If traffic and drainage requirements can be met to the satisfaction of these requirements, mountable curb types may be used on parking lots where snow removal operations may cause damage.
- C. Refer to Civil Standard Detail [ST-G2010-2](#), Curb and Gutter.

## 10.0 TRAFFIC CONSIDERATIONS

### 10.1 Traffic Impact Analysis

- A. Provide a Traffic Impact Analysis to determine improvements required to initiate the impact to adjacent facilities.
- B. Roads and access improvement plan with recommendations by development phases, identifying all needed improvements and the improvements that are the responsibility of the project. These recommendations shall be based on both the morning and evening peak hour projected volumes with an emphasis on the safety aspects of the designs.
- C. Traffic impact analysis shall be performed by a registered Professional Engineer (PE) and Institute of Transportation Engineer (ITE) certified Professional Traffic Operations Engineer (PTOE). Concise summary and findings and recommendations shall be submitted for the approval of the LANL Traffic Engineer.

### 10.2 Temporary Traffic Control Devices

- A. All temporary traffic control devices shall conform to the MUTCD, latest edition.
- B. Traffic control plans or guidelines shall be developed to provide safety for drivers, bicyclists, pedestrians, workers, enforcement/emergency officials, and equipment, with the following factors being considered:
  - 1. The basic safety principles governing the design of permanent roadways and roadsides shall also govern the design of temporary traffic control zones.
  - 2. Traffic control plans shall be prepared by a registered Professional Engineer (PE) who is certified as a Professional Traffic Operations Engineer (PTOE).

3. A temporary traffic control plan, in detail appropriate to the complexity of the work project or incident, shall be prepared and approved by the LANL Traffic Engineer – as shall any proposed changes to the plan. Submit daily inspection logs to the LANL Traffic Engineer for review.
  4. The traffic control plan shall address public notice, adjacent facilities, emergency service, and local transit.
- C. To provide acceptable levels of operations, routine day and night inspections of temporary traffic control elements shall be performed as follows:
1. Traffic Control Management shall conform to the New Mexico Department of Transportation, Section 618.
  2. Individuals who are knowledgeable (IMSA or AATSA trained and certified) in the principles of proper temporary traffic control shall be assigned responsibility for safety in temporary traffic control zones.
  3. Temporary traffic control zones shall be carefully monitored under varying conditions of road user volumes, light, and weather to check that applicable temporary traffic control devices are effective, clearly visible, clean, and in compliance with the temporary traffic control plan. Daily inspection log shall be submitted for review by the LANL Traffic Engineer.
- D. Design drawings shall indicate the disposition of all temporary traffic control devices, including work suspensions.

## **G2020 PARKING LOTS/PARKING STRUCTURE LAYOUTS**

- A. Provide for erosion and drainage control, prevention of frost damage, ease of maintenance, and a reasonably dust-free surface. Provide impervious surfaces with proper drainage in storage areas to prevent moisture penetration into the base course and subgrade.
- B. Where possible, use GI/LID features to promote infiltration, evapotranspiration or capture and re-use of surface drainage prior to routing to existing storm drainage system (*see G20 GEN 1.B above*).
- C. Provide parking for employee, handicap, visitor, government, motorcycle and bicycle parking. Loading zone and service vehicle parking must also be designated. *Guidance: Consider HOV spaces (van/carpool), especially when LEED certification is a goal.*
- D. Bumper blocks, guardrails, and other obstructions are not appropriate in parking lots due to snow removal concerns. Pavement markings shall consist of 2 coats of paint, and appropriate signs shall be installed per the Manual on Uniform Traffic Control Devices, latest edition.
- E. Provide parking areas with a maximum gradient of 5% and a minimum gradient of 1.00%. The maximum and minimum grades are to be used only where more desirable grades prove very uneconomical and difficult to obtain. For parking lot entrance/exit grade, refer to this document's Subsection G2010 (6.0A).
- F. Meet the provisions of 28CFR36, Appendix A, Americans with Disabilities Act Accessibility Guidelines (ADAAG), for parking and access into the building.
- G. Refer to LANL Civil Standard Detail [ST-G2020-1](#), Parking Layout.

- H. Conform to ESM Electrical Chapter 7, Section G4020 for Site Lighting Improvements.
- I. Submit parking lot layouts, striping, and signage plans to LANL Traffic Engineer for approval.
- J. Multi-level parking structures concept and design shall be reviewed and approved by the LANL Traffic Engineer. Structures shall conform to Institute of Transportation Engineers ([ite.org](http://ite.org)) guidelines unless LANL Traffic Engineer approves otherwise.
- K. *Guidance: Reference LANL Site and Architectural Design Principles (pgs 44-45) and Sustainable Design Guide (Sect 3 pg 44-45), on [Architectural Chapter Webpage](#), for expectations.*

## **G2030 PEDESTRIAN AND BICYCLE FACILITIES**

### **1.0 SIDEWALKS**

- A. Exterior sidewalks shall be a minimum of 6 feet wide. Locate to prevent intrusions (e.g. outward-opening windows, future tree growth).
- B. Refer to Civil Standard Detail [ST-G2030-1](#), Sidewalks.
- C. Comply with the ADA Regulations, NMDOT, Pedestrian Access Details, Drawing Set 608, and New Mexico Accessible Parking Checklist, latest editions.

### **2.0 TRAILS**

- A. *Guidance: Reference U.S. DOT Federal Highway Administration Recreational Trails Program, AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities, USDA Forest Service Accessibility Guidebook for Outdoor Recreation and Trails, and American Trails Organization.*

### **3.0 BICYCLES**

- A. Comply with AASHTO GBF, Guide for Development of Bicycle Facilities.
- B. *Guidance: Reference LANL Site and Architectural Design Principles (pgs 52-53 and 80-81) and Sustainable Design Guide (Sect 3 pg 45), on [Architectural chapter webpage](#), for expectations. U.S. DOT Federal Highway Administration Bicycle and Pedestrian Guidance.*

## **G2040 SITE DEVELOPMENT**

### **1.0 GENERAL**

- A. *Guidance: Reference LANL Site and Architectural Design Principles (pgs 65-74) on [Architectural chapter webpage](#), for expectations.*

### **2.0 FENCING**

- A. See ESM Chapter 9 Security and obtain approval of the physical protection system from the Laboratory's Security Division.

- B. Consult with LANL Emergency Response Group for approval of location and sizes of access gates in perimeter/security fences for fire-fighting equipment access.
- C. For secured facilities requiring a security fence refer to the Civil security fence Standard Detail [ST-G2040-1](#) and LANL Master Specification [32 3113](#), Chain Link Fences and Gates. See also ESM Chapter 9, Security.
- D. For boundary fencing refer to Civil Standard Detail [ST-G2040-2](#) and LANL Master Specification [32 3100](#), Fences and Gates.

### 3.0 SIGNS

- A. See Engineering Standards Manual Chapter 4, Architectural, Section B-C\_GEN, Exterior Signs subsection.
- B. Submit the signage plan to LANL Traffic Engineer for review and approval on compliance with MUTCD Roadway Standards.

### G2050 LANDSCAPING

- A. See Engineering Standards Manual Chapter 4, Architectural, Section B-C GEN, Landscaping subsection.
- B. Submit designs and specifications for coordination with Operations and Infrastructure Program Office, Site Planning and Landscape Design POC, and to Utilities and Institutional Facilities Group for compatibility with Grounds maintenance program.