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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, *FWO-UI*	Dennis McLain *FWO-FE*
1	8/16/04	Chapter divided into four sections based on UniFormat. Complete text revision. FEM now ESM.	Edward J. Hoth, *FWO-UI*	Gurinder Grewal *FWO-DO*
2	10/27/06	Administrative changes only. Organization and contract reference updates from LANS transition. IMP and ISD number changes based on new Conduct of Engineering IMP 341. Master Spec number/title updates. Other admin changes.	Edward J. Hoth *MSS-UI*	Kirk Christensen, *CENG*

CONTACT THE CIVIL ENGINEERING STANDARDS POC

for upkeep, interpretation, and variance issues

Ch. 3, G20	**Civil POC/Committee**

G20 SITE IMPROVEMENTS

G20GEN

1.0 HYDROLOGICAL ANALYSES

A. Perform hydrologic analyses prior to design of drainage within LANL boundaries. Use the Rational Method *(MSS-UI recommendation is 25 year return storm)* and the C-factors in Table G20GEN-1 to compute peak flows from small drainage areas less than 5 acres for sizing drainage structures. Use the methodologies outlined within the U.S.D.A. National Resources Conservation Service: National Engineering Handbook, Part 630, Hydrology in hydrologic analyses for large off-site drainage areas. *Guidance: Refer to Section 309 (Drainage) of the New Mexico State Highway Department New Mexico Design Manual and U.S.D.A. Natural Resources Conservation Service publication Urban Hydrology for Small Watersheds, Technical Release 55 for further guidance.*

B. In accordance with DOE Standard 1020 http://tis.eh.doe.gov/techstds/standard/std1020/STD-10202002.pdf, the potential for flooding shall be considered for LANL sites that are located in defined flood plains. Both 100-year and 500-year flood plain levels have been calculated and plotted for drainage basins in LANL (ENV-Water Quality Group maintains this documentation). Utilize this information for the evaluation of local flooding potential and surface drainage analysis. *(Steve McLin,* ERSS-ES, *665-1721).* For design of facilities subject to flood plain hydrology, use DOE-STD-1020 guidance of a 25 year, 6 hour rainfall event (*was page 4-12, Section 4.3.3, January 2002 edition*) for design of surface drainage or water collection systems.

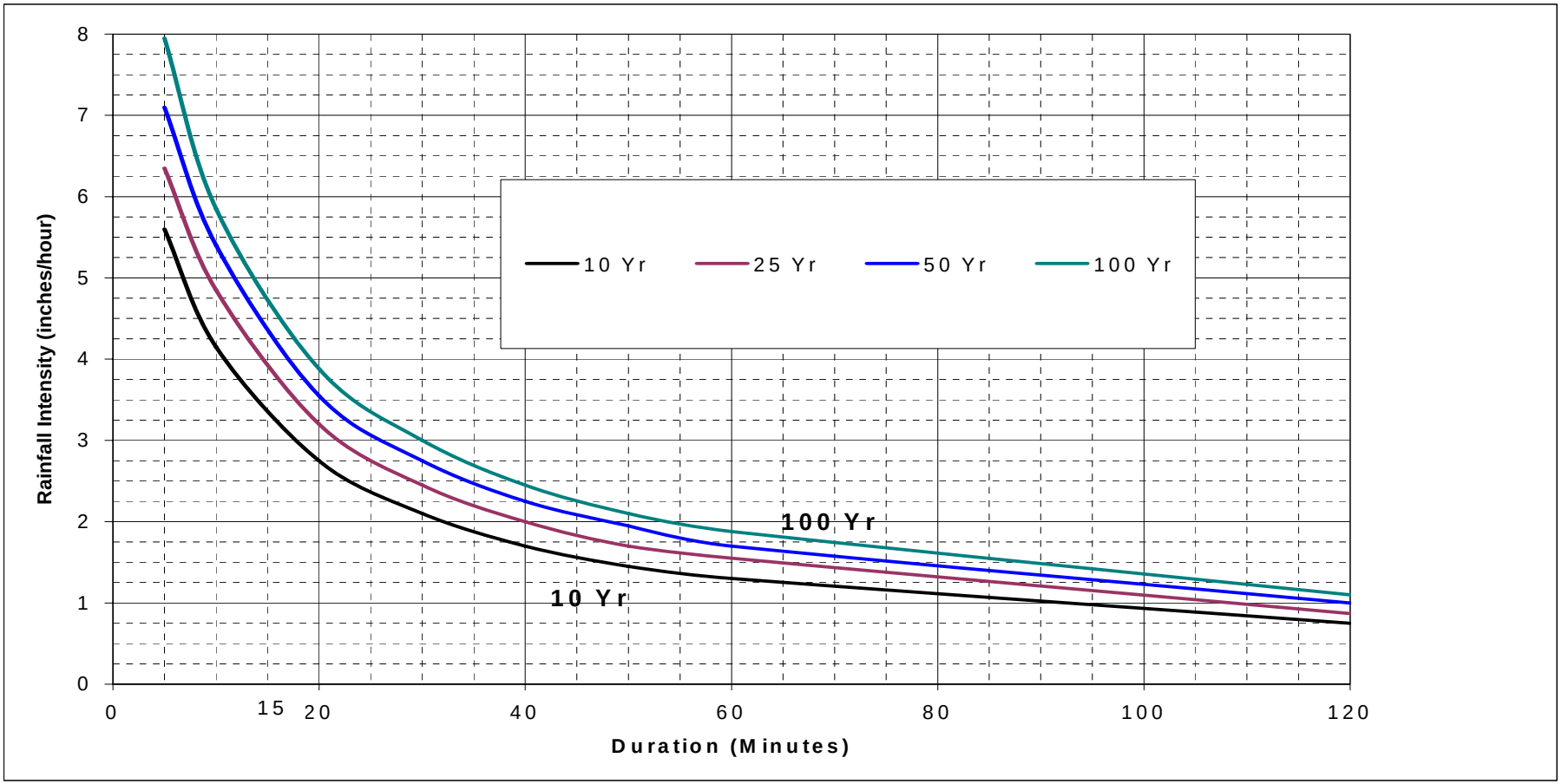
C. Use the Rainfall Intensity-Duration-Relationship Curve, Figure G20GEN-1, in conjunction with previously described methodologies.

D. Submit hydrologic analyses to LANL MSS-Utilities and Infrastructure Group (UI) 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[1]



[1] From E. Hoth data.

TABLE G20GEN-1
C-Factors

Use the following C-factors in conjunction with the Rational Method. (New Mexico Sate Highway Department - Hydrology Section). Note: Approval of "C" Factor by ,MSS-UI is required.		
URBAN		
Residential-lawns	Flat	.05 - .15
	Steep	.35
Suburban		.25 - .40
Single-family		.30 - .50
Multifamily		.40 - .60
Apartments		.50 - .70
Business	Downtown	.70 - .90
	Neighborhood	.50 - .70
Industrial	Flat-commercial	.80
	Heavy-commercial	.50 - .80
	Light-commercial	.50 - .80
Streets	Asphalt concrete	.70 - .95
	Portland concrete	.80 - .95
	Gravel, shoulders	.40 - .60

RURAL Subtract the given numbers from unity; interpolate when appropriate.								
TOPOGRAPHY			SOIL			COVER		
Flat	Rolling	Hilly	Tite Clay	Med C-L	Open S-L	Barren	Cult	Woods
.3	.2	.1	.1	.2	.4	.0	.1	.2

2.0 HYDRAULIC DESIGN

A. Design site grading to provide surface drainage to the existing storm drainage system, where possible. Make use of open ditches. Install pipe culverts at all walk (12 in. min.) and road (24 in. min.) crossings. 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.

B. Submit hydraulic design calculations, accompanied by preliminary design drawings, to the LANL Project Leader and MSS-Utilities and Infrastructure or the ESM Civil POC for review and approval.

C. *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*.

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 Control 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]
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 Control Engineer *(in MSS-UI).*

2.0 CLASSIFICATION OF ROADS

A. Consult with the LANL Traffic Control 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 G20GEN, Hydrological Analyses and Hydraulic Design, for drainage analysis and improvements.

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 Control 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 & Infrastructure 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 Control 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 shall consist of a minimum of 4 inches of Plant Mix Bituminous Pavement (PMBP), dense Grade B, on top of a minimum of 8 inches of aggregate base course on a prepared subbase with prime coat and tack coat.

C. Parking lot paving shall consist of a minimum of 4 inches of Plant Mix Bituminous Pavement (PMBP), dense Grade B, on top of a minimum of 8 inches of aggregate base course on a prepared subbase with prime coat and tack coat.

D. 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.

E. Pavement markings shall consist of 3 coats of paint, and appropriate signs shall be installed.

F. Refer to Civil Drawings 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 MSS-UI.

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 Drawing(s) 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 Control 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. All 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 Control Engineer – as shall any proposed changes to the plan. Submit daily inspection logs to the LANL Traffic Control 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 Control 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. 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.*

C. 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.

D. 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 chapter Section G2010 (*6.0A).*

E. Meet the provisions of 28CFR36, Appendix A, Americans with Disabilities Act Accessibility Guidelines (ADAAG), for parking and access into the building.

F. Refer to Civil Drawings ST G2020-1, Parking Layout.

G. Conform to ESM Electrical Chapter 7, Section G4020 for Site Lighting Improvements.

H. Submit parking lot layouts, striping, and signage plans to LANL Traffic Control Engineer for approval.

I. Multi-level parking structures concept and design shall be reviewed and approved by the LANL Traffic Control Engineer. Structures shall conform to Institute of Transportation Engineers (ite.org) guidelines unless LANL Traffic Control Engineer approves otherwise.

J. *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 Drawing(s) ST-G2030-1, Sidewalks.

C. Comply with ADA and NMDOT, Pedestrian Access Details, Drawing Set PAD-001, latest edition.

2.0 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.*

G2040 SITE DEVELOPMENT

1.0 FENCING

A. Obtain approval of the physical protection system from the Laboratory's Security (SEC) 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 drawings 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 Drawing ST-G2040-2, and LANL Master Specification 32 3100, Fences and Gates.

2.0 SIGNS

A. See Engineering Standards Manual Chapter 4, Architectural, Section B-C_GEN, Exterior Signs subsection.

B. Submit the signage plan to LANL Traffic Control Engineer for review and approval on compliance with MUTCD Roadway Standards.

3.0 GENERAL

A. *Guidance: Reference LANL Site and Architectural Design Principles (pgs 65-74) on Architectural Chapter Webpage, for expectations.*

G2050 LANDSCAPING

A. See Engineering Standards Manual Chapter 4, Architectural, Section B-C_GEN, Landscaping subsection.

B. Submit to MSS-Utilities and Infrastructure Group for compatibility with Grounds maintenance program.