Conduct of Engineering
Request for Variance or Alternate Method

To display the *VAR Request Metadata* pane for this document, click **File > Info > Properties > Show Document Panel.**

1.0 General

1.1 Document Number: VAR-10468	1.2 Revision: 0
1.3 Brief Descriptive Title: Revised Storm Water Material (ESM Civil Chapter 3)	
1.4 Affected Program: Engineering Standards	1.5 Request Type: Variance
1.6a Affected Tech Area 99	1.6b Affected Buildings Sitewide
1.7 Requestor: Oruch, Tobin H Organization: Enter text.	
1.8 Revision History Revision Number Changes and Comments 0 Initial issue.	

2.0 Affected Conduct of Engineering Program/Documents

2.1 Affected "P" Document: P342 Engineering Standards If against the P document itself, revision (or ***N/A***): N/A	2.2 Subordinate or related document(s) [AP, master spec, LANL ESM chapter & section; or code, Order, standard, etc.]: Document Title/No.: ESM Chapter 3 Civil, Section G10-30GEN General Civil Requirements Revision 3 Document Title/No.: ESM Ch. 3 Section G10 Site Preparation Revision 3 Document Title/No.: ESM Ch. 3 Section G20 Site Improvements Revision 3
2.3 Section/Paragraph: G10-30GEN: 3.5 LANL Documents; G10: Article 6.0 Storm Water Compliance; G20GEN: 1.0 Hydrological Analysis and 2.0 Hydraulic Design	
2.4 Specific Requirement(s) as Written in the Document(s): Entirety of material listed in Field 2.3 above.	
2.5 Contractual, preference, or other basis for requirement in 2.4: The requirements include LANL contractual and preferential statements and guidance.	
2.6 Type of VAR from ESM Chap 1, Z10 [*Applies only to standards variances*) Type 2	2.7 Discipline Civil

3.0 Request Information & Comments

3.1 NCR required (work has occurred)? No If Yes, NCR Number: Enter text.		
3.2 System/Component Affected OpSystem Acronym & Name URG - Roads and Grounds System Number or Name USTW		3.3 Highest ML Level ML-4
3.4 Proposal with Justification/Compensatory Measures: Replace Civil Chapter 3 material listed in 2.3 above with that in Attachment 1 of this Variance. The attached is up-to-date and in a single document.		
3.5 Attachments Document Title or Description Storm Water Compliance and Design Requirements		
3.6a Project ID N/A	3.6b: Project Name N/A	3.6c: Code of Record Date N/A
3.7 Duration: Lifetime	3.8a If Finite Period, Start Date: Click to enter a date.	3.8b End Date: Click to enter a date
3.8c Provide the PFITS number for tracking removal/correction: [PFITSNum]		
3.9 USQD/USID required (Nuclear, High/Mod Hazard)? No If Yes, USQD/USID Number Click here to enter text.		
3.10 QA Review for process change matters potentially affecting LANL's NQA-1 implementation Is a QPA Determination required?: No If ***Yes***, then: Choose an item. QPA Comments: Enter text..		
3.11 POC Determination: Accept POC Comments: Enter text..		
3.12 Management Program Owner's (SMPO) Approval for P341 and APs; P342, ESM, ML-1 and -2, and Contract Matters; and P343 SMPO Determination: Accept Comments: Enter text..		

4.0 Participant Signatures

<u>**NOTE**</u>***:*** *DO NOT ADD NAMES FROM WITHIN WORD! <u>Save and close the form first</u>, then do 1-4 below:*

1. *From the SharePoint library, select the document, then click the **ellipsis (…)** in the second column; a small dialog appears*
2. *In the small dialog click the **ellipsis** again*
3. *Click **Edit Properties** and check out the document if prompted toEnter names using the controls provided, then **Save***

4.1 POC (Management Program Owner's Representative): O'Brien, John Henry	Organization ES-UI	Signature Official signature in SharePoint
4.2 Facility Design Authority Representative [FDARName] FDAR signature not required ☒	Organization Enter text..	Signature
4.3 LANL Owning Manager (FOD or R&D/Program) [FODorPrgmMgrName] FOD or Program Manager signature not required ☒	Organization Enter text..	Signature
4.4 Quality Reviewer's Name: [QPAName] QPA review/signature not required ☒	Organization Enter text.	Signature
4.5 Safety or Security Management Program Owner's Approval for P341 and APs; P342, ESM and Contract Matters; and P343 Streit, Jim SMPO signature not required (Type 1 variance) ☐	Organization ES-DO	Signature Official signature in SharePoint
4.6 Additional Signer 1 [AdditionalSigner1] Role: Enter text.	Organization Enter text.	Signature

4.7 Additional Signer 2 [AdditionalSigner2] Role: Enter text.	Organization Enter text.	Signature

4.8 CoE Administrator Signature Salazar-Barnes, Christina L <u>NOTE</u>: The CoE Admin is always the last signature placed on this document. The date of that signing is the date of this document.	Signature Official signature in SharePoint

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1.0 Storm Water Compliance

A. Best Management Practices

1. All projects, regardless of size, shall utilize appropriate Best Management Practices (BMPs). BMPs shall be indicated in the design, in a Storm Water Pollution Prevention (SWPP) Plan, or as specified by LANL EPC-CP. These site specific BMPs may be temporary or permanent in nature. Furthermore, BMPs may be required to meet State and Federal regulatory requirements.

2. The LANL Storm Water BMP Manual provides guidance on BMP selection, design, and use. BMP measures are used to prevent or mitigate pollution from any activity. They include processes, procedures, schedule of activities, prohibitions on practices, and other management practices to prevent or reduce water pollution. They include measures for stabilization, sediment and erosion control, and storm water management and can generally be broken down into two categories—structural and non-structural. Examples of non-structural BMPs include minimizing removal of established vegetation, good housekeeping, preventative maintenance, employee training, record keeping and reporting, visual inspections, and spill prevention and response. Some examples of structural BMPs are detention ponds, silt fence, gravel bags, straw wattles, earth berms, culvert inlet and outlet protection, riprap, turf reinforcement mats, and construction entrances/exits.

   When soil is disturbed, implement a combination of erosion and sediment controls. Erosion controls manage sediment movement at the source. Sediment controls retain sediment that has eroded before the sediment leaves the site.

   Additional information on BMP use is provided in LANL Master Specifications Sections 32 9219 *Seeding* and 01 5705 *Temporary Controls and Compliance Requirements*.

B. EISA Section 438 Compliance

Section 438 of the Energy Independence and Security Act (EISA) of 2007 requires all Federal facility development or redevelopment projects 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 pre-development hydrology of the property with regard to the temperature, rate, volume, and duration of flow.

The EPA Technical Guidance document for implementing EISA 438 defines “the pre-development hydrologic condition” as “the combination of runoff, infiltration and evapotranspiration rates and volumes that typically existed on the facility site before ‘development’ on a greenfield site” —meaning any construction of infrastructure on undeveloped land, typically ponderosa pine forest, pinon-juniper woodland or grassland for our area. The project “footprint” would include all areas disturbed during construction activities, including the facility location, access routes, and staging/stockpiling/construction support areas, etc.

Implementation of EISA compliance must be achieved through the use of green infrastructure/low impact development (GI/LID) methods. A minimum of two GI/LID features are required. Design guidance associated with EISA Section 438 compliance is provided in Section 2.

C. NPDES CGP and SWPP Plan

1. Projects where construction activities disturb one (1) acre or more, or where activities are part of an EPA defined larger "common plan" of development that disturbs 1 acre or more, are required to obtain permit coverage to discharge storm water from the site in accordance with the EPA's National Pollutant Discharge Elimination System (NPDES) Construction General Permit (GCP). Submission of a Notice of Intent (NOI) to EPA is required to obtain Permit coverage. The NPDES CGP requires temporary storm water controls during construction activities and permanent post-construction storm water controls.

   Refer to section 6.E.2 for NPDES CGP requirements specific to the State of New Mexico.

2. Projects subject to NPDES CGP requirements must develop a Storm Water Pollution Prevention (SWPP) Plan prior to obtaining Permit coverage. A SWPP Plan identifies project activities, describes potential pollutant sources, and identifies the BMPs to minimize the potential for erosion and discharge of potential.

3. LANL will provide a SWPP Plan for the project. A/E and Subcontractor personnel shall provide assistance in SWPP Plan preparation through the following:

   a. Provide the EPC-CP Group with the necessary design information in sufficient format and detail to complete the SWPP Plan.

   b. Prepare design drawings and specifications that correspond with the SWPP Plan and NPDES Permit requirements. Project documents must specify the methods, materials, and procedures associated with the temporary and permanent stabilization of disturbed areas.

   c. Work with the LANL EPC-CP Group to develop documentation that the specified BMPs prevent an increase in sediment yield and flow velocity from pre-construction, pre-development conditions. Permanent GI/LID and conveyance structures must meet the design requirements described in Section 2.

   d. Design permanent storm water management devices and sediment controls to control pollutants in storm water discharges. Such measures include, but are not limited to, perennial vegetation, storm water detention ponds with controlled outlet structures, sediment basins, turf reinforcement mats, and rock check dams.

e. Design of stabilization controls at all disturbed unpaved areas and areas not covered by permanent structures. Achieve stabilization by covering soil with measures including, but not limited to, native perennial vegetation, asphalt, concrete, gabions, geotextiles, base course, gravel, or riprap.

f. Design of velocity dissipation devices at discharge locations and along the length of any outfall channel to provide a non-erosive flow velocity from the structure to the receiving water course. In doing so, the natural physical and biological characteristics and functions are maintained and protected (e.g., no significant changes in the hydrological regime of the receiving water).

g. Design of velocity dissipating devices for all other areas of concentrated flow such as drainage ways, steep slopes, and compacted earth surfaces. These include such controls as riprap, turf reinforcement mats, check dams, and waterbars. Subsection 2.E provides additional guidance on channel velocity control.

h. If permanent BMPs can be utilized during the construction phase to meet the objectives of temporary sediment and erosion controls, specify their installation in lieu of temporary controls.

D. 404/401 Permits

1. If project construction activities involve crossing, working in, or otherwise disturbing a watercourse, Clean Water Act Section 404 Dredge and Fill Permit coverage from the U.S. Army Corps of Engineers and a New Mexico Environment Department Section 401 Water Quality Certification may be required. A watercourse is defined as “any river, creek, arroyo, canyon, draw, or wash, or any other channel having defined bed and banks with visible evidence of the occasional flow of water or high water mark.” The Permit and Certification must be obtained prior to performing any work in a watercourse. Allow at least one to two months for 404/401 Permit Applications.

2. 404/401 Permits will require the specification and implementation of BMPs, and integration with design. Identification of excavation and fill material quantities will also be required for submission to the USACE to obtain 404/401 permit coverage. Excavation and fill material types and quantities will be determined by project personnel (subcontractor or designer) and provided to EPC-CP. The drawings shall clearly show the watercourse area and identify the required BMPs.

3. The EPC-CP Group will file the 404/401 Permit Application and review the BMPs identified in design documents to ensure compliance with Permit requirements. All information required for the permit application shall be forwarded to the EPC-CP Group by the LANL STR Project Coordinator for inclusion in the Permit Application. Contact the EPC-CP Group for more information.

E. State of New Mexico Requirements

1. Per New Mexico Administrative Code (NMAC) 20.6.2.1201. Notice of Intent to Discharge:

   a) Liquids or other substances (e.g., fertilizer, hydraulically applied mulches, soil stabilizing agents, etc.) applied to the ground may require an NOI to Discharge be submitted to the New Mexico Environment Department (NMED). Contact the LANL EPC-CP Group for more information and to determine whether liquids or other substances to be used are covered under an existing lab-wide NOI.

   b) Substances applied to the ground shall not be applied in a watercourse.

2. The NMED 2017 NDPES CGP State Conditions of Certification require that projects discharge storm water at or less than pre-development rates. GI/LID structures are recommended. Section 2 provides GI/LID design guidance.

3. The NM Office of the State Engineer requires detention features to release water within 96 hours.

F. Flood Effects on Structures

The potential for flooding and precipitation impact shall be considered for structures that are located in defined flood plains in accordance with DOE Standard 1020 Chapters 5 and 7. Utilize available information for the evaluation of local flooding potential and surface drainage analysis for minimum design of surface drainage or water collection management systems. Refer to DOE-STD-1020 and its Tables 5-2, 5-3, 7-1 & 7-2 (Regarding Table 7-2, the 100-year return period for PDC-1 for precipitation structural loads is equivalent to that of the IBC for rainfall intensity, and it’s 2” per hour [i.e., per IBC Fig. 1611.1 & LA 14165 Table 2-21]). [1]

2.0 Hydrological Analyses and Design of GI/LID and Conveyance Structures

This section provides direction for the analysis and design of storm water quality treatment, flood control, and general conveyance structures. It also clarifies the design of permanent storm water controls to meet NPDES CGP and/or EISA Section 438 compliance requirements for construction, development, and/or re-development projects.

Use Table 1 to determine the specific storm water requirements for your project.

Project designs and hydrologic calculations, including the rationale for multi-stage discharge designs, must be reviewed and approved by EPC-CP.

Site-specific soil properties, such as infiltration rate, may be required for larger projects. Contact EPC-CP for guidance.

[1] LANL is in the process of completing the analysis (PFHA) and documentation of all data necessary for project implementation of the STD, including the DBFL indicating where our flood plains are located.

Questions about CGP, EISA or other storm water related requirements may be directed to lanlstormwater@lanl.gov.

Table 1. Compliance Requirements Guide to Usage

Project Type	EISA	CGP	Subsection
Construction projects ≥ 5,000 ft^2 and < 1 acre	X		B
Construction projects ≥ 1 acre (or < 1 acre and part of a common plan-of-development)	X	X	C
Design of flood control or drainage structures (e.g., culverts, drop inlets, larger conveyances)	n/a	n/a	D

A. GI/LID Design

GI/LID methods 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 GI/LID features, associated retention/detention classification, and potential runoff volume reduction credit are listed in Table 2. Additional guidance related to the selection and design of GI/LID features is provided in the LANL Low Impact Development Standards for Stormwater posted with LANL ESM Chapter 3; ST-G20GEN-1 Standard Details for LID are available on the Civil Details webpage located here.

Table 2. GI/LID features, retention/detention classification and potential runoff volume reduction credit.

GI/LID Feature	Function	Potential Credit[1]
Green Roof	Retention	Feature Volume
Tree/Tree Boxes	Retention	Feature Volume
Rain Garden/Infiltration Basin	Detention	Feature Volume
Vegetated/Rock-Lined Swale with Rock Check Dams[2]	Detention	0.1 in
Filter Basin	Detention	Feature Volume
Permeable Pavement	Retention	Feature Volume
Vegetated Strips/Buffers[3]	Detention	0.1 in
Revegetation[3]	Detention	0.1 in
Rain Barrels/Cisterns	Retention	Feature Volume

[1] Potential credit for features listed on this table will either be (1) the total volume provided by the feature or (2) 0.1 in.. The 0.1-in. credit represents the volume calculated by multiplying 0.1 in. of depth over the drainage area served by the specific feature. This volume credit may be deducted from the total volume required in the post-construction condition for the storm water quality treatment system.

[2] Swales must have a permeable bottom, be ≥ 50 ft. long, ≥ 2ft wide, and ≥ 1ft deep, with 2:1 side slopes and rock check dams spaced in accordance with the LANL Storm Water BMP Manual, Section 4.2.

[3] Consult with EPC-CP for credit (email LANLStormwater@lanl.gov).

B. EISA-only Compliance Requirements:

Upon completion of construction activities, storm water discharges must be at rates, volumes and durations less than or equivalent to pre-development conditions as determined through appropriate industry standard methodologies (see Subsection D below) using the 95th percentile design storm. Table 3 provides design storm rainfall totals. The meteorological station nearest to the project site shall be used.

- Use Curve Number (CN) values listed in Table 4 to determine pre-development and post-construction runoff volumes when using the Technical Release 55 (TR-55) Method.
- Use the runoff coefficients, rainfall intensity-duration relationship curves, and precipitation rates listed in Table 5, Figure 1, and Table 6, respectively to determine runoff volumes when using the Rational Method.

The following steps must be completed to achieve this requirement:

1. **Determine water quality treatment volumes:** Calculate pre-development and post-construction runoff volumes for the project area using the 95th percentile design storm. The difference between the pre-development and post-construction runoff volume is the Excess Runoff Volume (ERV). GI/LID structures and storm water management basins must be designed to detain the ERV for a minimum of 4-hrs and drain within 96-hrs. Meeting or exceeding the minimum drain time of 4-hrs will assure that pre-development discharge rates are not exceeded. Additionally, unless retention depth is ≤ 6 in., demonstrate that storm water will infiltrate/evaporate within 96-hrs.
2. **Size conveyance features:** Calculate and design conveyance structures to (a) discharge the ERV from the site and (b) manage larger frequency storm events. Figure 2 provides examples of discharge structure configurations from a storm water detention basin.
   a. Identify and design a minimum of two GI/LID features to manage the ERV. Ensure infiltration or discharge of the ERV from site features in no less than 4-hrs. Select and size conveyance or outlet structures (i.e., weir or orifice) to achieve this.
   b. To manage larger frequency storms, calculate the post-construction discharge rate for the 25-yr, 2-hr storm event. Size outlet structures from the project site to convey the 25-yr, 2-hr flows, unless site or project requirements dictate a larger storm frequency, as discussed in Subsection D. EISA requires management only of storm water discharge from the developed project area (does not include run-on). However, conveyance features for the 25-yr, 2-hr flows must be sized to accommodate the entire contributing area. Run-on diversion around the site is recommended to simplify construction and reduce costs of storm water management.

Table 3. Design Storm Rainfall Totals (inches) by Meteorological Station

Met Station	Period of Record	95th Percentile	2-yr, 24-hr	25-yr, 2-hr	100-yr, 24-hr
TA-06	29	0.90	1.28	1.90	3.05
TA-49	32	0.88	1.30	1.92	3.56
TA-53	27	0.84	1.09	1.48	2.44
TA-54	27	0.83	1.14	1.68	2.54
NCOM	33	0.94	1.33	1.76	2.73

Table 4. Curve numbers for TR-55 runoff volume calculations.

Cover Type[1]	CN: HG-C	CN: HG-D
Impervious	98	98
Urban Open Space/Lawns	79	84
Base Course/Gravel	89	91
Bare Ground/Dirt	87	89
Paved Roads w/curbs and storm drains	98	98
Paved Roads w/open ditches	92	93
Fair Grassland/Herbaceous	81	89
Fair Brush	57	63
Pinon/Juniper	85	89
Ponderosa Pine	77	83

[1] For redevelopment projects at LANL, estimate predevelopment land use cover based on elevation specific reference conditions. Pre-development reference conditions are 50 percent Ponderosa Pine/50 percent Fair Grassland/Herbaceous cover for projects over 7,000 feet elevation and 50 percent Pinon/Juniper - 50 percent Grassland/Herbaceous cover for projects under 7,000 feet elevation (e.g., use 83 as a CN for a site with HG-C). Hydrologic Soil Groups are available on the LANL internal network located here.

Table 5. Rational Method runoff coefficients

Use the following C Factors in conjunction with the Rational Method		
Lawns	Flat 0-2 Percent Slope	0.05-0.15
	Average 2-7 Percent Slope	0.15-0.25
	Steep Slope >7 Percent	0.25-0.35
Roofs		0.75-0.95
Industrial	Heavy Commercial	0.60-0.90
	Light Commercial	0.50-0.80
Streets	Asphalt	0.70-0.95
	Portland Concrete	0.80-0.95
	Gravel Shoulders	0.40-0.60
Unimproved		0.10-0.30

Figure 1. Rainfall Intensity-Duration-Relationship Curves. These curves were calculated using TA-06 meteorological tower data. Extrapolated rainfall rate values less than 15 minutes duration can be found in Table 6.

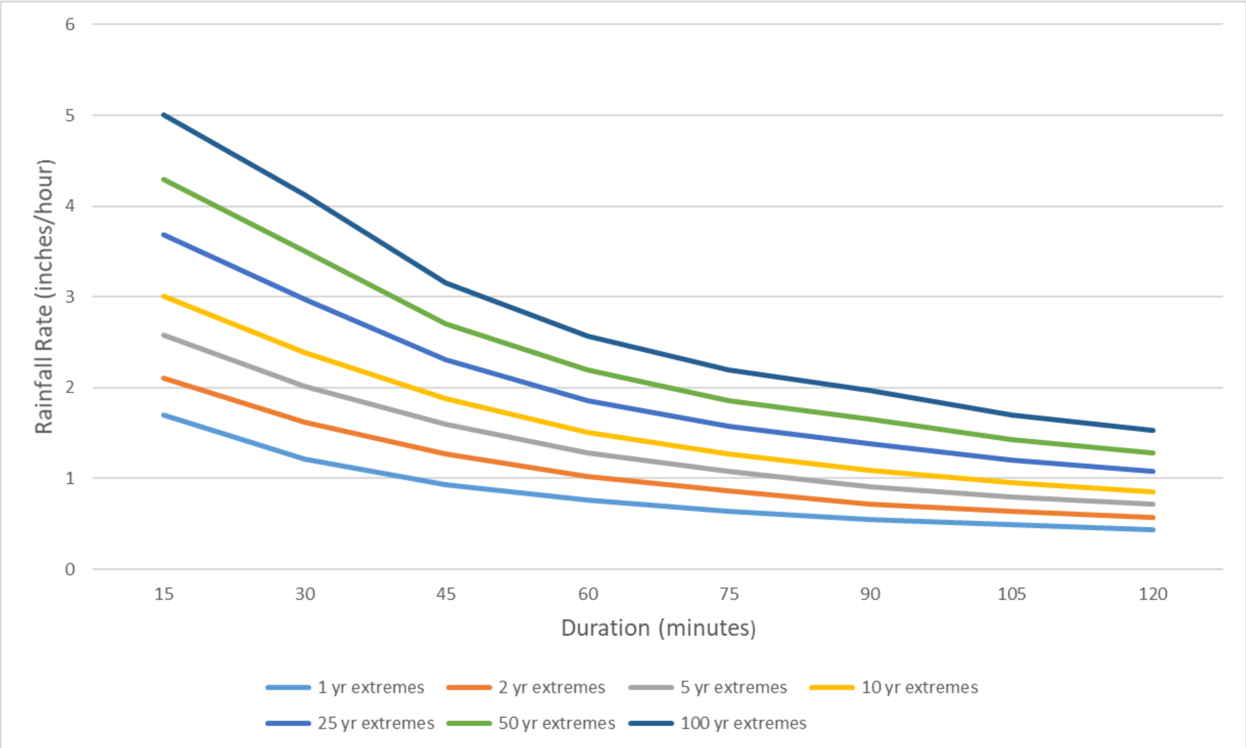

Table 6: Extreme Precipitation Rates[1]

Duration (minutes)	1 yr.	2 yr.	5 yr.	10 yr.	25 yr.	50 yr.	100 yr.
5	*2.03*	*2.43*	*2.95*	*3.42*	*4.17*	*4.83*	*5.60*
10	*1.86*	*2.27*	*2.76*	*3.22*	*3.93*	*4.56*	*5.30*
15	1.70	2.11	2.58	3.01	3.69	4.30	5.01
30	1.21	1.62	2.02	2.39	2.97	3.50	4.13
45	0.93	1.27	1.60	1.88	2.31	2.70	3.16
60	0.76	1.02	1.28	1.51	1.86	2.19	2.57
75	0.64	0.86	1.08	1.27	1.58	1.86	2.19
90	0.55	0.72	0.91	1.09	1.38	1.65	1.97
105	0.49	0.64	0.80	0.95	1.20	1.43	1.70
120	0.44	0.57	0.72	0.85	1.08	1.28	1.53

[1]Corresponding to the curves in Figure 1, extreme precipitation rates (inches/hour) for a set of average recurrence intervals from 1 to 100 years, and a set of durations from 5 to 120 minutes. The method described above cannot be applied to durations less than the observed data frequency of 15 minutes, so values for 5 and 10 minute durations (in italics) are instead estimated by linearly extrapolating from 15 and 30 minute durations.

Figure 2. Examples of discharge structure configurations. A. 2-stage weir plate, B. Riser pipe with orifices C. Flash board riser and D. Riser constructed of masonry blocks with gaps between blocks.

A

B

C

D

C. EISA and CGP Compliance Requirements:

Upon completion of construction activities, storm water discharges from projects with construction footprints greater than or equal to 1 acre (or less than 1 acre if part of a common plan-of-development) must be at rates, volumes and durations less than or equivalent to pre-development conditions as determined through appropriate industry standard methodologies (see Subsection D below) using the 2-yr, 24-hr design storm. Table 3 provides design storm rainfall totals. The meteorological station nearest to the project site shall be used.

- Use Curve Number (CN) values listed in Table 4 to determine pre-development and post-construction runoff volumes when using the TR-55 Method.

- Use the runoff coefficients, rainfall intensity-duration relationship curves, and precipitation rates listed in Table 5, Figure 1, and Table 6, respectively to determine runoff volumes when using the Rational Method.

The following steps must be completed to achieve this requirement:

1. **Determine water quality treatment volumes and release rates:** Calculate pre-development and post-construction runoff volumes for the project area for the 2-yr, 24-hr storm. The difference between the pre-development and post-construction runoff volume is the ERV. GI/LID structures and storm water management basins must be designed to detain the ERV.

    - For sites between 1 and 5 acres in size the ERV must be detained for a minimum of 12-hrs and drain within 96-hrs.
    - If the site is greater than 5 acres in size the ERV must be detained for a minimum of 2-hrs and drain within 96-hrs.
    - If the site is < 1 acre and part of a common plan of development, the ERV must be detained for a minimum of 4-hrs and drain within 96-hrs.

    Calculate the pre-development and post-construction discharge rate for the 2-yr, 2-hr storm. Compare the pre-development and post-construction discharge rates for the 2-yr, 2-hr storm to assure that pre-development discharge rates are not exceeded. Additionally, if a retention/filter basin system is utilized, demonstrate that storm water will infiltrate/evaporate within 96-hrs, unless retention depth is ≤ 6 in.

2. **Size conveyance features:** Calculate and design conveyance structures to (a) discharge the ERV from the site and (b) manage larger frequency storm events. Figure 2 provides examples of discharge structure configurations from a storm water detention basin.

    a. Identify and design a minimum of two GI/LID features to manage the ERV. Ensure infiltration or discharge of the ERV from site features in no less than the minimum drain times described above. Select and size conveyance or outlet structures (i.e., weir or orifice) to achieve this.

    b. To manage larger frequency storms, calculate the post-construction discharge rate for the 25-yr, 2-hr storm event. Size outlet structures from the project site to convey the 25-yr, 2-hr flows, unless site or project requirements dictate a larger storm frequency, as discussed in Subsection D. Conveyance features for the 25-yr, 2-hr flows must be sized to accommodate the entire contributing area. The CGP requires management of all storm water discharge from the developed project area (which includes run-on). Run-on diversion around the site is recommended to simplify construction and reduce costs of storm water management. Run-on not diverted must be included in the ERV calculation for the project site.

D. Flood Control Conveyances and Drainage Structures Design Requirements:

Perform hydrologic analyses using the 25-yr, 2-hr return storm. Table 3 provides design storm rainfall totals. The meteorological station nearest to the project site shall be used. If project or site requirements dictate, or the site is within a 100-year floodplain, use a 100-yr, 24-hr return storm to size conveyance and drainage structures after the requirements of Subsections B or C above are met. Use appropriate industry standard methodologies such as the Rational Method, Technical Release 55 (TR-55), SWMM, and/or HEC methodology to compute runoff volumes and peak flows from drainage areas and for sizing drainage structures based on site characteristics.

E. Channel Velocity Control

1. Riprap— Use riprap to dissipate energy and reduce velocity in channels subject to erosion and to prevent scour at hydraulic structure inlets and outlets.

- Appropriately size riprap taking into account uniform flow depth, shear stress at maximum flow depth, permissible shear stress, and flow velocity. Identify permissible shear stress using published values or by calculating the value with the following equation:

  $\tau_p = 4.0\ D_{50}$, where D_{50} is in feet.

  Also ensure that stone size is adequate to withstand movement due to flow velocity (i.e., prevent rolling or migration).

- Riprap thickness shall be 12 inches or equal to the diameter of the largest rock size in the gradation (approximately 1.5-3 times D_{50}), whichever is greater.

- Place filter fabric beneath riprap applications. The fabric must be able to transmit water faster than the soil and be of sufficient size that the base material does not escape through the fabric.

- Do not use round stone on channel side slopes steeper than 3:1. Do not use riprap on slopes steeper than 1.5:1.

- Do not use flat slab-like stones.

2. Gabions— Consider the use of wire enclosed riprap, gabion baskets, or gabion mattresses if adequate riprap size is not available, if slopes are too steep for standard riprap placement, or for locations of high flow velocity.

- To prevent gabion mattresses from sliding down a slope, stabilize their base with a key trench. The trench depth shall be two times the mattress thickness and the trench width shall be three times the mattress thickness. Within a channel, tie the upstream and downstream ends of the mattress into the bank to prevent currents from unraveling the mattress.

- The minimum rock size diameter for gabion baskets shall not be less than four inches.

- The minimum rock size diameter for gabion mattresses shall not be less than three inches.

- The minimum gabion mattress thickness shall be 1.5 times the largest rock size.
- Place filter fabric beneath gabion applications. The fabric must be able to transmit water faster than the soil and be of sufficient size that the base material does not escape through the fabric.

3. Culverts—In channel applications, place riprap or gabions flush with the invert of culverts. The break between a steep slope and a culvert entrance should equal 3-5 times the mean rock diameter of the mattress thickness.

4. Check Dams—Design the center of check dams (the spillway) at least 6 inches lower than the outer edges. Where applicable, extend abutments 18 inches into the channel bank. Maximum spacing between check dams shall provide that the toe of the upstream dam is at the same elevation as the top of the downstream dam.

5. Other Methods—Contact Civil Standards POC and EPC-CP Group for advisement and approval prior to use.

F. Hydraulic Design

1. 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 7.B above).

2. 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.

3. Produce hydraulic design calculations, accompanied by preliminary design drawings, submit for approval to the LANL STR for coordination with EPC-CP and U&IF and for review and approval.

G. References

1. Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act. EPA 841-B-09-001. Environmental Protection Agency, Washington, D.C. 2009.

2. Denver Urban Drainage and Flood Control District. Urban Storm Drainage Criteria Manual, Volume 2. September 2017.

3. USDA National Resources Conservation Service: National Engineering Handbook, Part 630, Hydrology (for hydrologic analyses of large off-site drainage areas)

4. *USDA Natural Resources Conservation Service publication Urban Hydrology for Small Watersheds, TR 55 (for smaller drainage areas)*

5. *Guidance: Refer to American Society of Civil Engineers Publications 77–Design and Construction of Urban Stormwater Management Systems, 37–Design and Construction of Sanitary and Storm Sewers, and 62-64 – Standard Guidelines for the Design, Installation, and Operation and Maintenance of Stormwater Impoundments.*

6. *Guidance: Reference LANL Site and Architectural Design Principles (pgs 83-88 of LA-UR 01-5383) and Sustainable Design Guide (pgs 147-153), on Architectural Chapter, for additional expectations on integration of landscaping and storm water management.*

7. *Guidance: 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.*

8. *Guidance: FHWA Hydraulics publication HDS 5, Hydraulic Design of Highway Culverts.*

H. Definitions

Common Plan of Development - The "common plan" of development or sale is broadly defined as any announcement or piece of documentation (including a sign, public notice or hearing, sales pitch, advertisement, drawing, permit application, zoning request, computer design, etc.) or physical demarcation (including boundary signs, lot stakes, surveyor markings, etc.) indicating construction activities may occur on a specific plot. LANL-specific examples of a common plan of development could include a common PR-ID, EX-ID, funding source, planning document, NEPA analysis document, etc.

EISA Section 438 – Section 438 of the Energy Independence and Security Act of 2007 requires federal agencies to manage storm water runoff from federal development projects to protect water resources**.**

Excess Runoff Volume (ERV) – The difference between the pre-development (green field conditions) and post-construction runoff volume

Green Infrastructure/Low Impact Development (GI/LID) – a set of management approaches and technologies that utilize and/or mimic the natural hydrologic cycle processes of infiltration, evapotranspiration and use.

Maximum Extent Technically Feasible – All technical options, regardless of cost, have been employed to restore the pre-development hydrologic conditions with respect to storm water temperature, rate, volume and duration of flow.

Pre-development - the combination of runoff, infiltration and evapotranspiration rates and volumes that typically existed on the facility site before 'development' on a greenfield site (meaning any construction of infrastructure on undeveloped land, typically ponderosa pine forest, pinon-juniper woodland or grassland for our area)

Technical Infeasibility – Stormwater strategies, such as infiltration, evapotranspiration, and harvesting and use have been used to the Maximum Extent Technically Feasible, and that full employment of these types of controls are infeasible due to site constraints.