Chapter 3

Storm Water Design Considerations and Methods

3.0 Introduction

This section provides an overview of current methods employed to evaluate a suite of design issues facing Alaska property owners or their designee (herein referred to as *designers*), with specific emphasis on methods already used in Alaska. Under some circumstances, methods evolving from the activities in the lower-48 states are discussed to provide food-for-thought for Alaska designers and municipalities.

The information in this chapter is targeted at planning and designing permanent storm water BMPs. Local governments might have their own terminology and reference system for the documents/calculations submitted to obtain the necessary permits, but for the majority of Alaska's land area, state or federal agencies are the permitting authority.

This section discusses considerations for designers preparing engineering plans for permanent BMPs for submission to ADEC or to the MOA, which has developed its own design considerations. The City of Fairbanks, the City of North Pole, the FNSB and City and Borough of Juneau are in the early stages of developing their own design considerations. The diverse environmental conditions throughout Alaska frequently require designers to be aware of local, state, and federal guidelines/design requirements. This section provides an overview of the elements that should be considered in permanent BMP design, defines terms for use in the storm water dialog between regulators and designers, and provides references that individuals can use to advance their permanent storm water planning.

3.1 The Role of Soils

Soils are extremely important to consider when planning for, selecting and designing permanent storm water management controls. This section discusses resources available on Alaska soils and some basic concepts for classifying Alaska soils.

Soil surveys conducted by the NRCS of the USDA are available for many areas of Alaska (see Link 26 in Appendix A for the Web link to the surveys).

The ADNR Division of Geological and Geophysical Surveys have mapped the engineering geology for many areas of Alaska (see Link 27 in Appendix A for the Web link to these reports).

These resources provide generalized information on soils and characterize soils down to an order of tens to hundreds of acres. It is probable that even on small sites (less than 5 acres) there will be localized variation in surface soils and underlying soil horizons. Designers of permanent BMPs should sufficiently characterize soil variation to establish site-specific permanent storm water management. For linear projects such as roadways, it is likely that the type of soil encountered will vary significantly along the project length.

There are two options for designers trying to obtain soil information on their building locations: (1) hire a professional soil scientist, or (2) obtain an idea of what soil is present by using the field method described by USDA to *do-it-yourself* in the Web link below. The USDA Web site also has useful information on soil characterization, including accepted field methods for identifying soil texture (see Link 28 in Appendix A).

Many soil structural and hydrologic parameters can be determined once the soil texture has been classified. For hydrologic calculations, soil infiltration is an important parameter, often correlated with soil texture. With regard to storm water generation, Alaska soils can be characterized on the basis of the amount of summertime infiltration expected. Soil infiltration capacity is described below for high, medium and low infiltration soils and is related to generalized soil texture classes.

For new development areas, it is important to note whether any portion of the site is non-discharging (where either no centralized drainage network exists or where sufficient infiltration exists to minimize runoff for all but the largest rainfall events). An example of the first case would be a series of homes arrayed along a ridgeline road. While runoff is generated by impervious surfaces (roof tops and the roadway) any storm water discharge is dispersed into backyards or open areas. There is no central collection of storm water/snowmelt runoff and, hence, no centralized discharge. The other condition that creates a non-discharging site is where soil infiltration is greater than the most common rainfall rates. An example of this is where construction falls on the footprint of soil/gravel borrow pits. Exposed gravel/cobble will naturally infiltrate runoff during summer conditions and help absorb snowmelt during winter thaw conditions.

High Infiltration Soils

This condition occurs where shallow or sandy soils are over gravels/cobble layers or areas where overburden soils have been removed/excavated to expose gravel/cobble sublayers. The soil texture classes typically associated with high infiltration rates are sandy and sandy loam soils and soils with high percentages of gravel and cobble (soils that have a sustained infiltration rate greater or equal to 0.5 inch per hour).

For sites with high infiltration soils, a reasonable case can be made that minimum permanent BMPs are required if the runoff from impervious surfaces can be managed by routing the flow onto adjacent high infiltration pervious area. The site might actually have no discharge for the majority of rainfall events, even though the runoff generated increases because of new impervious surfaces.

It should be noted that not all land uses are appropriate for infiltration-type permanent storm water BMPs. Section 2.7 helps identify storm water pollution hotspots, or land uses that generate or can generate contaminants that should not be infiltrated.

Moderate Infiltration Soils

Silt loam or loam soil classes are examples of moderate infiltration soils, assuming there is sufficient clearance from water tables, and no low permeability sublayers exist. When thoroughly wetted, these soils will typically infiltrate less than 0.5 inch per hour but greater than 0.1 inch per hour. Moderate infiltration soils could be sufficient to use infiltration-type BMPs to limit summertime storm water discharges; however, care is required to ensure that wintertime issues of freezing, freeze/thaw, and snow accumulation are also addressed.

Low Infiltration Soils

Low infiltration conditions exist where infiltration is less than 0.1 inch per hour. This condition is found where soils are naturally slow to infiltrate or where soils freeze easily to create wintertime impermeable layers. Permafrost areas are considered to be low infiltrating, as are soils with impervious layers, such as fragipans or other types of cementous layers. Soil texture classes typically associated with low infiltration rates are clay, silty clay and clay loam.

Low infiltration soils tend to not be suitable for BMPs designed to infiltrate storm water. As a result, storm water controls usually incorporate ponding (e.g., detention ponds) or flow-through systems (e.g., treatment swales) as a means to minimize the impact of storm water discharge.

Saturated Soils

Saturated soils exist where water seasonally ponds because of topography or subsurface conditions. The NRCS soil surveys provide useful information on the frequency of water ponding/flooding, the depth-to-groundwater and identifies subsurface restrictive soil layers as a part of the soil surveys (see Link 29 in Appendix A). In most cases, most or all features associated with wetlands are evident if saturated soils are present. Wetlands are generally defined by soil moisture content and vegetative characteristics. A Web link to the process for defining a wetland provided by the COE (COE 2007) is in Appendix A (see Link 30).

Areas with seasonally saturated soils are probably inappropriate for most construction activities in the absence of corrective measures. In general, fill material is placed upon these soils to raise the site elevation sufficiently to allow the installation of structures. Designers should consider storm water BMPs that use ponding (e.g., detention ponds, wetlands) or flow-through systems (e.g., treatment swales) as a means to minimize the effects of storm water discharge.

Unique problems are presented by organic soils found in muskeg. Decomposed peat has a tremendous water-holding capacity, so that when it is moved or disturbed during construction, not only does the soil break down and liquefy, but the water is also released. In addition, often muskeg is underlain by an impermeable layer of glacial till, which produces fine sediments once disturbed.

For Alaska designers considering developing on or near saturated soils, it is recommended reviewing the contents of Section 3.2.3 (Wetlands).

Overview of Soil Hydrologic Analysis

Alaska designers can choose from an array of accepted mathematical models for estimating soil hydrologic losses due to infiltration. In some cases, local municipalities will provide designers with approved hydrologic modeling software and a range of accepted parameter values. When applying mathematical models, reasonable assumptions should be made that are applicable to the site and are representative of site conditions. Data needs vary among the models, some more intensively than others. Builders often hire professionals to implement their hydrologic analysis, because the selection of parameters requires professional judgment.

A partial list of hydrologic modeling software accepted by some Alaskan municipalities includes the following:

ILLUDAS
TR55-1986
WinTR553
WinTR20 SCS
HEC-HMS
Rational Method

For small sites (e.g., a single residential structure), generally the easiest to implement method for determining peak event runoff rates is the rational method. Note that the default coefficient values for the rational method are provided below. Table 3-1 provides default hydrologic soil group (HSG) assignments for common soil texture classes. The HSG can be correlated with the USDA curve numbers (CN) to compute runoff volumes as a function of soil and land use/land cover. Note, HSG for many U.S. soils is available in the documentation for TR-55 (USDA 1986) (see Link 31 in Appendix A).

Table 3-1. Correlation of soil texture with soil infiltration rate and HSG

Soil texture	Infiltration rate (if not measured directly) inches per hour[a]	Hydrologic Soil Group	General soil infiltration classification
Coarse sand (or coarser)	3.6	A	High
Loamy coarse sand	3.6	A	High
Sand	3.6	A	High
Loamy Sand	1.63	A	High
Sandy Loam	0.5	A	High
Loam	0.24	B	Moderate
Silt loam	0.13	B	Moderate
Sandy clay loam	0.11	C	Moderate
Clay loam	0.09	D	Low
Silty clay loam	0.06[b]	D	Low
Sandy clay	0.05	D	Low
Silty clay	0.04	D	Low
Clay	0.02	D	Low

a. Infiltration rates represent the lowest value for each textural class presented in Table 2 of Rawls et al, 1998.

b. Generalized values provide in Brakensiek and Rawls, (1983).

Table 3-1 also links soil texture with typical infiltration rate and a hydrologic soil grouping, parameters that can be used in hydrologic analyses the absence of more specific information. In addition, Table 3-2 relates various land use/covers with the HSG and provides designers with default information necessary to employ the rational method to estimate site runoff rates.

Table 3-2. Rational formula coefficients for various HSGs

HYDROLOGIC SOIL GROUP													
		A soil			B soil			C soil			D soil		
Slope		0-2%	2-6%	+6%	0-2%	2-6%	+6%	0-2%	2-6%	+6%	0-2%	2-6%	+6%
Landcover													
Forest, brush	a*	0.05	0.08	0.11	0.08	0.11	0.14	0.10	0.13	0.16	0.12	0.16	0.20
	b*	0.08	0.11	0.14	0.10	0.14	0.18	0.12	0.16	0.20	0.15	0.20	0.25
Wetland	a							0.12	0.16	0.20	0.12	0.16	0.20
Parkland	a	0.05	0.10	0.14	0.08	0.13	0.19	0.12	0.17	0.24	0.16	0.21	0.28
	b	0.11	0.16	0.20	0.14	0.19	0.26	0.18	0.23	0.32	0.22	0.27	0.39
Cultivated	a	0.08	0.13	0.16	0.11	0.15	0.21	0.14	0.19	0.26	0.18	0.23	0.31
	b	0.08	0.14	0.22	0.16	0.21	0.28	0.20	0.25	0.34	0.24	0.29	0.41
Pasture	a	0.12	0.20	0.30	0.18	0.28	0.37	0.24	0.34	0.44	0.30	0.40	0.50
	b	0.15	0.25	0.37	0.23	0.34	0.45	0.30	0.42	0.52	0.37	0.50	0.62
Lawn	a	0.17	0.22	0.35	0.17	0.22	0.35	0.17	0.22	0.35	0.17	0.22	0.35
Barren	a	0.25	0.30	0.35	0.25	0.30	0.35	0.50	0.55	0.60	0.50	0.55	0.60
Graded slope													
Gravel	a	0.25	0.30	0.35	0.25	0.30	0.35	0.50	0.55	0.60	0.50	0.55	0.60
Earthen	a	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Drives, walks	a	0.75	0.80	0.85	0.75	0.80	0.85	0.75	0.80	0.85	0.75	0.80	0.85
Streets													
Gravel	a	0.50	0.55	0.60	0.50	0.55	0.60	0.50	0.55	0.60	0.50	0.55	0.60
Paved	a	0.85	0.86	0.87	0.85	0.86	0.87	0.85	0.86	0.87	0.85	0.86	0.87
	b	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	0.97
Impervious	a	0.85	0.86	0.87	0.85	0.86	0.87	0.85	0.86	0.87	0.85	0.86	0.87
	b	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	0.97

* - a, ≤ 25-year, 24-hour event; b, >25-year, 24-hour event

Modified from: Rawls et al. 1981; WSDOT 2005.

3.2 Considerations for Protecting Sensitive Receiving Waters

Alaska designers should be aware of multiple categories of waters that are considered *sensitive*. Sensitive waters tend to receive special attention from regulating agencies because of the use of the waters, (e.g., supporting drinking water, supporting high-value fish habitat). This section reviews the most common circumstances of which Alaska designers should be aware and provides references and contacts for them to determine the extent and nature of potential issues they might face at their construction site.

3.2.1 Drinking Water Source Protection

Designers should note where storm water discharge is expected to discharge into drinking water source protection areas. Local communities should be contacted to determine where surface or shallow groundwater is used or contributes to a public water source. In addition, ADEC's Division of Environmental Health provides information on the locations where drinking water protection efforts are underway (see the Web Link 32 in Appendix A).

For drinking water protection areas, additional steps might be required to treat storm water discharge before its departure from the development site boundaries (for details, see the discussion of the UIC Program and related links in Chapter 1).

3.2.2 Anadromous Fish Habitat and Other Resource Protection Areas

As described in Chapter 1, the Anadromous Fish Act requires that an individual or governmental agency provide prior notification and obtain approval from the ADF&G "to construct a hydraulic project or use, divert, obstruct, pollute, or change the natural flow or bed" of a specified anadromous waterbody or "to use wheeled, tracked, or excavating equipment or log-dragging equipment in the bed" of a specified anadromous waterbody. As it relates to permanent storm water BMPs, designers should address two basic concerns:

- The discharge of storm water pollutants (e.g., TSS/silts that clog spawning beds)
- Sustaining predevelopment flow rates to protect stream habitat

In addition to Alaskan waters that have been designated as anadromous fish habitat, select communities have further prioritized their waterbodies. Designers should contact their local community to assess if the storm water from new developments/redevelopments will reach priority waters. In some cases, additional storm water controls might be required for new development activities. Examples of this include detention/retention ponds with long residence times and flow-velocity, energy-dissipation devices.

The ADF&G Division of Habitat is responsible for identifying anadromous waters and provides information through its Web site (Link 33 in Appendix A).

3.2.3 Construction Adjacent to Wetlands and Discharges to Wetlands

The location of proposed construction activities establishes which permitting authority Alaska designers should first contact regarding wetlands. Some Alaska communities have already approved procedures for assessing wetlands, have already delineated their wetlands and have specific requirements if wetlands are adjacent to proposed construction sites. Depending on location, the interaction between permanent storm water BMPs and wetlands will be established through the COE, ADEC, the local municipality (e.g., Juneau or Anchorage), or a combination of them all. This section summarizes some of the roles/efforts of the different regulatory agencies, and provides designers with contacts/resources for assessment of site-specific requirements.

Municipal Wetlands Management Efforts

Designers seeking to discharge to wetlands in MOA must obtain site-specific guidance from MOA's Physical Planning Section for Class C Wetlands. To facilitate the process, MOA has prepared an atlas indicating where wetlands are in the Anchorage Bowl and Eagle River area of MOA (see Web Link 34 in Appendix A).

In addition, the *Anchorage Storm Water Treatment in Wetlands: 2002 Guidance* provides pretreatment requirements for discharge to natural wetlands (see Link 35 in Appendix A).

To obtain ordinances related to the discharge of storm water to natural wetlands in the jurisdiction of other Alaska municipalities, designers should contact the public works or planning department of the municipality.

ADEC Wetlands Assessment Efforts

ADEC has established local guidance for assessing wetlands and wetland functionality on the basis of the hydrogeomorphic approach (HGM) methodology. This guidance affects areas inside and outside the Coastal Management Program. Wetlands are managed to assure adequate water flow, nutrients, and oxygen levels and avoid adverse effects on natural drainage patterns, the destruction of important habitat, and the discharge of toxic substances. ADEC (2003a, 2003b) and ADEC/U.S. Geological Survey (USGS) (1999) has developed draft guidance for the (1) Cook Inlet Basin, (2) Southeast and South Central Alaska, and (3) Interior Alaska.

3.2.4 Impaired Waters (Includes a Map or Source for Maps; 303(D) List; TMDLs)

Designers should note where storm water is expected to discharge into waters characterized as impaired. ADEC provides information on the locations where special actions could be required to manage storm water from new construction sites (see the Web Link 36 in Appendix A).

Impaired waters might have specific environmental problems, such as high levels of bacteria, low levels of oxygen and high levels of metals. As a result, targeted management may be required before discharge of storm water from new construction sites. The appropriate permanent storm water management level and type can be established only on a case-by-case basis.

ADEC's approach for abatement of known impairments is to develop implementation guidance on the basis of an estimated TMDL for the contaminants of concern. ADEC will identify the source of and the means to reduce pollutants and the amount of pollutants that can be introduced to the waterbody while still allowing overall recovery to proceed. With this knowledge, parties who introduce pollutants are given an *allowance*, or TMDL for that pollutant or prescriptive actions called BMPs that they must follow to stay within such an allowance.

3.3 Design Considerations for Alaska

Designers are faced with a range of numeric criteria/conditions when planning for a new development. Designing permanent storm water BMPs is just one facet of storm water management. An integrated set of engineering criteria, known as the unified storm water sizing criteria have been developed to size and design structural storm water controls. The unified storm water sizing criteria are intended to be used collectively to address the overall storm water effects from a development site. When used as a set, the unified criteria control the entire range of hydrologic events, from the smallest runoff producing rainfalls (≥ 0.1 inch) to the 100-year storm. Table 3-3 points readers to the proper sections in this chapter for some of these criteria and to obtain additional information about other topics relevant to managing storm water in Alaska, and Table 3-4 outlines these criteria.

Table 3-3. Storm water design cross-reference for Alaska designers

Criteria/condition	Characterization of design standard/criteria	Primary decision point	Reference section
Storm Water Quality			
Water Quality Volume	State minimum standard or state-adopted federal numeric criteria*	Identification of regulatory condition	Section 3.3.1
Low-Impact Designs	Best Professional Judgment	Identification of runoff reduction opportunities	Section 3.3.5
Discharge Point Design			
Groundwater Recharge Volume	Per local ordinance	Contact local municipality	Section 3.3.2
Activity-Specific Designs			
Road Crossings	Either local ordinance or AASHTO** Drainage Guidelines	Identification of controlling authority	Section 3.3.4
Flood Prevention	Either local ordinance or federal criteria	Identification of controlling authority	Section 3.3.4
Channel Protection	Recommendations based on best current practice	Identification of design goal	Section 3.3.3

* Local ordinance may exceed state or federal requirements

** AASHTO = American Association of State Highway and Transportation Officials

Table 3-4. Unified sizing criteria

Sizing criteria	Recommended method
Water Quality Volume WQv (acre-feet)	Treat the runoff from 90% of the storms that occur in an average year. For Alaska, this equates to providing water quality treatment for the runoff resulting from a rainfall depth of 1.25 inches or less. The goal is to reduce average annual post-development TSS loadings by 80%. $WQv = (Rv) \times (A) \times (P) / 12$ where Rv = site runoff volume coefficient; A = site drainage area (acres); P = design rainfall depth (90% cumulative frequency depth) (~ 0.5 to 1.25 inches)
Recharge Volume Rev (acre-feet)	Fraction of WQv, depending on predevelopment HSG. $Rev = [(S)(Rv)(A)] / 12$ where S = soil specific recharge factor in inches
Channel Protection Storage Volume Cpv	Provide 24 hours of extended detention of the runoff from the 1-year, 24-hour duration storm event to reduce bank-full flows and protect downstream channels from erosive velocities and unstable conditions.
Overbank Flood Protection Qp	Provide peak discharge control of the 5-year storm event such that the post-development peak rate does not exceed the downstream conveyance capacity or cause overbank flooding in local urban watersheds. Some jurisdictions may require peak discharge control for the 2-year storm event.
Extreme Flood Protection Qf	Evaluate the effects of the 100-year storm on the storm water management system, adjacent property, and downstream facilities and property. Manage the effects of the extreme storm event through detention controls or floodplain management.

(Adapted from the *Iowa Stormwater Management Manual*, Version 1; 2007)

Figure 3-1 illustrates the relative volume requirements of each of the unified storm water sizing criteria and demonstrates that the criteria are *nested* within one another, i.e., the extreme flood protection volume requirement also contains the overbank flood protection volume, the channel protection volume, and the water quality treatment volume. Figure 3-2 shows how these volumes would be allocated and configured in a typical storm water wet-detention basin (wet pond) designed to handle all four criteria.

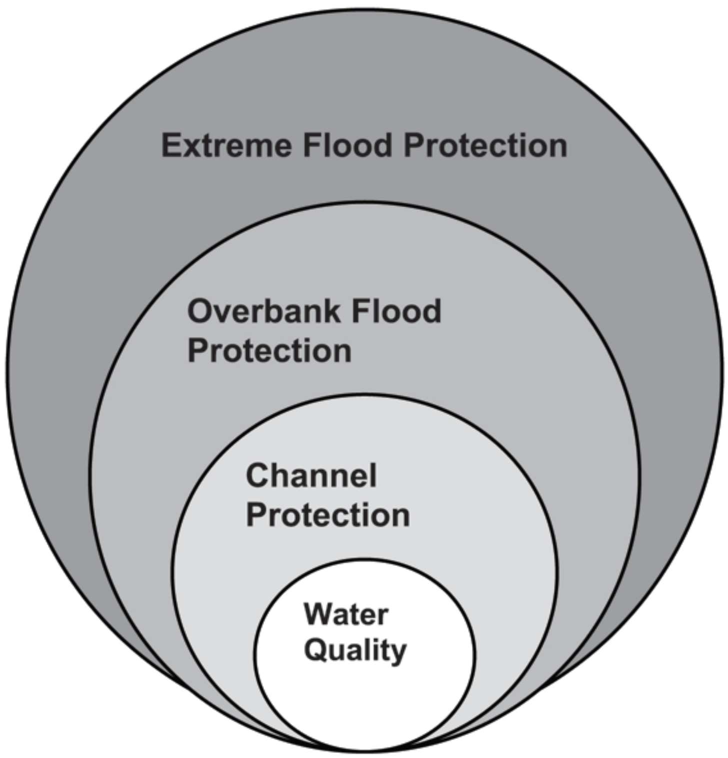

Figure 3-1. Relationship of the unified sizing criteria volumes
(Adapted from the *Iowa Stormwater Management Manual*, Version 1; 2007)

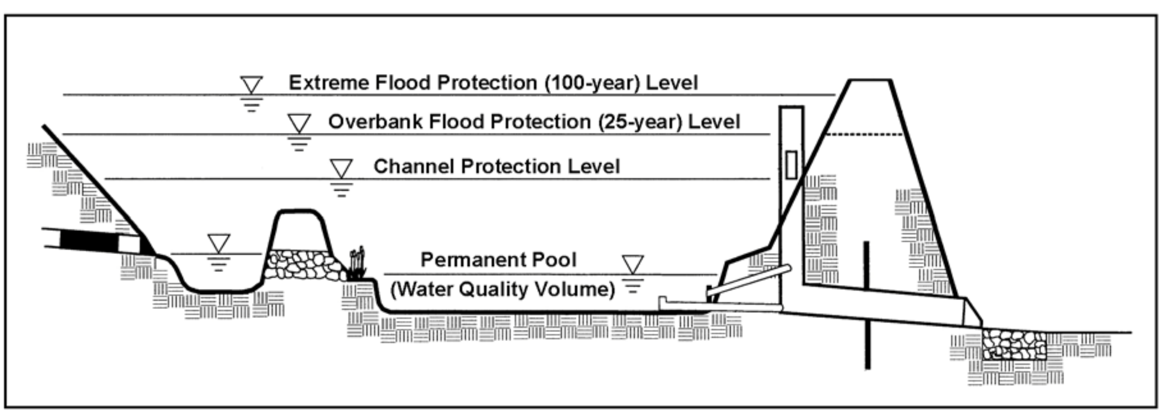

Figure 3-2. Configuration of unified sizing criteria water surface elevations in a wet pond (Adapted from the *Iowa Stormwater Management Manual*, Version 1; 2007)

This section provides insight into storm water structure design and the management of storm water quality and quantity. As with the lower-48 states, storm water management in Alaska is evolving, with many communities establishing and expanding the storm water requirements designers must meet. In general, the larger the community, the more extensive and advanced the storm water management requirement. Alaska designers should start by seeking out current municipal-specific ordinances governing NPS pollution at the Web Link 37 in Appendix A.

Some Alaska municipalities have established which storm water BMPs are accepted, under what circumstances they are approved and have targeted programs aimed at minimizing future storm water problems. For example, MOA provides Alaska designers with specific guidelines in its *Stormwater Treatment Plan Review Guidance Manual* (see Web Link 38 in Appendix A).

3.3.1 Water Quality Volume Criteria

Table 2-4 presents recommended water quality volumes for design within the five Alaska Climatic Regions in the absence of values already established by municipalities for their jurisdiction. Values in Table 2-4 are based on treatment of either the 90 percent storm or the end-of-season snowmelt event. Without specific local requirements, Table 2-4 values should be used to determine if permanent storm water BMPs are to be designed to meet storm water or meltwater conditions. Preliminary designs can be based on the values shown in Table 2-4, assuming that designers incorporate more accurate/local data (if available) for their final BMP designs. Additional data sources include the following:

From municipalities with jurisdiction at the site of construction

- Any local Intensity-Duration-Frequency information
- Locally published design event data

Statewide sources

- End-of-season snowmelt data is at the Western Regional Climate Center (WRCC 2007) (see Web Link 39 in Appendix A).
- Technical Paper 47 (TP-47) for rainfall event totals (see Web Link 40 in Appendix A).

Designers should be aware of requirements for sites served by a storm sewer system. For projects using oil and grit separators, to obtain an ADEC *letter of non-objection* for discharge to storm sewers, an applicant must demonstrate that their proposed oil and grit separator(s) has (have) the ability to remove at least 50 percent of particles 20 microns in size from storm water runoff during the 2-year, 6-hour rain event. A separate storm sewer is “a conveyance or system of conveyances (i.e., ditches, curbs, catch basins, underground pipes, etc.) that is designed or used for collecting or conveying storm water and that discharges to surface waters of the State."

Designers should determine if their municipality has already performed hydrologic analyses and determined the water quality volume that must be managed (e.g., Anchorage sets the water quality volume to be the first 0.5 inch of runoff). In addition, municipalities might have simplified meeting water quality requirements by prescreening permanent storm water BMPs for different size and types of development conditions. This includes specifying BMP-sizing criteria, including facility depths, inlet and outlet design requirements (MOA 2007).

As discussed in Chapter 2, designers in Alaska must consider snowmelt runoff in addition to rainfall runoff, when designing permanent storm water BMPs. There are no statewide design criteria specific to snowmelt. The approach taken by MOA, discussed below, can be considered a reasonable starting point for designers. Additional details are at the Web Link 41 in Appendix A.

The MOA approach uses a maximum melt event (an approximate 5-year return period). The maximum melt event hyetograph (0.9 inch of water over a 40-hour duration as depicted in Table 3-5) is applicable to sizing hydraulic devices and considering the potential for flooding. The peak runoff rate associated with the MOA maximum (5-year) melt event is approximately 0.06 inch per hour, or about 6 percent of the total event snowmelt.

Without specific local information, designers outside Anchorage (or elsewhere outside the Southcentral Climatic Region) can prorate the Anchorage March 23rd event hyetograph to estimate their own local design snowmelt event hyetograph. For example, if the estimated local snowmelt event volume is 1.25 inch (as water), the Table 3-5 hyetograph values would be adjusted upward by multiplying the hourly rates in Table 3-5 by 1.39 (1.39 = 1.25" / 0.9"). The resulting snowmelt hyetograph can be used to evaluate the design of permanent BMPs for locations where the meltwater event produces greater volumes than the local design rainfall event.

In addition to ensuring that permanent BMPs manage the design snowmelt event volume, designers should also ensure that proposed BMPs operate appropriately at the peak snowmelt runoff rate (when hydraulic devices might be compromised because of ice accumulation). Without other data, Alaska designers can assume 6 percent of the water volume in their end-of-season snowmelt event will be discharged through their hydraulic devices in a single hour during breakup (as noted in Table 3-5).

Table 3-5. Anchorage 5-year return period snowmelt hyetograph

5-Year recurrence (March 23, 1974)	
Time (hours)	**Snowmelt (inches)***
1	.01
2	.02
3	.02
4	.02
5	.02
6	.02
7	.03
8	.03
9	.03
10	.02
11	.02
12	.01
13	.01
14	.02
15	.01
16	.01
17	.01
18	.00
19	.00
20	.00
21	.00
22	.00
23	.00
24	.01
25	.03
26	.04
27	.05
28	.04
29	.04
30	.05
31	.06
32	.06
33	.06
34	.05
35	.04

Table 3-5. (continued)

5-Year recurrence (March 23, 1974)	
Time (hours)	**Snowmelt (inches)***
36	.03
37	.02
38	.01
39	.00
40	.00

* Inches of water

Source: *Design Criteria Manual*, Chapter 2 Drainage (MOA 2007)
(see Link 41 in Appendix A)

3.3.2 Groundwater Recharge Volume Criteria

There are no statewide criteria for the recharge of groundwater from storm water generated from new developments. However, as noted in Section 3.2.1, the protection of groundwater resources and wellhead areas is a concern in some locations. The ADEC Division of Environmental Health provides information on the locations where wellhead protection efforts are underway (see Web Link 42 in Appendix A).

Designers should note where storm water discharge is expected to discharge into wellhead/groundwater recharge protection areas. For wellhead/groundwater recharge areas, additional steps might be required to treat storm water discharge before its departure from the development site boundaries. Local communities should be contacted to identify if there are current or potential new efforts to protect neighboring public water sources.

3.3.3 Channel Protection Criteria

An increasing number of lower-48 communities are establishing criteria to limit erosive flows originating from new developments. However, it is not only a lower-48 problem. Urban development on steep slopes is relatively common in certain Alaskan communities, and the increase in the amount of impervious surfaces has produced major changes in stream hydrology. For example, recent models have indicated that runoff volumes have increased three- to fivefold in Anchorage watersheds from 1950 to 2000, and peak discharge rates have increased by a factor of 5 to 10. At the same time, dry-weather stream baseflows have declined by an order of magnitude over the same time frame because of lower groundwater recharge (MOA 2004).

ADEC recommends that to the extent practicable, the designer maintain postdevelopment peak runoff rate and average volume at levels that are similar to predevelopment levels, (such as what is required by MOA). To protect the integrity of stream channels, ADEC recommends that the increase in runoff volume from the one-year, 24-hour storm event be fully reduced through an acceptable combination of runoff reduction practices. These practices reduce runoff volume through canopy interception, soil infiltration, evaporation, rainfall harvesting, engineered infiltration, extended filtration or evapotranspiration. If runoff reduction is not feasible, as a general guideline consistent with the unified sizing approach, designers should provide a minimum of 24 hours of extended detention for the one-year, 24-hour design storm event in a pond or wetland.

The above criteria are intended to protect Alaska's stream habitat. One study identifies the typical post-development stream cross-section area as between 2 to 4 times larger than the preconstruction unless preventive measures are taken (CWP 2000). This channel erosion degrades stream and riparian habitat, and it increases maintenance costs for roadways.

Accepted Analytical Methods for Assessing Channel Protection

Alaska designers can choose from an array of references and accepted mathematical models for evaluating channel conditions, including the following models for determining the management of specific locations with stream bank erosion:

- Hydrologic Engineering Center (HEC) models including HEC-RAS
- Procedures outlined in Chapter 8 of the ADOT&PF Drainage Manual (see Web Link 43 in Appendix A).
- Peak flow regression equations (see the USGS report WRI 03-4188 at the Web Link 44 in Appendix A).
- Soil Conservation Service methods including TR-55 at the Web Link 45 in Appendix A).
- EPA SWMM at the Web Link 46 in Appendix A.

For methods on minimizing hydrologic changes due to new developments, see the discussion on LID concepts in Section 3.3.5.

3.3.4 Flood Control Criteria

Within their storm water ordinances, local communities/jurisdictions may establish their own minimum freeboard depth requirements and set the design flow magnitude (i.e., event return frequency) under which hydraulic structures must perform. Alaska designers should contact the local authorities to identify if local design criteria apply.

Meteorologic and hydrologic conditions in Alaska impose a very real flood risk to structures and property. Floods typically occur because of summer rainfall events, or in some areas of the state because of combinations of rainfall and snowmelt. Two types of flood prevention are discussed in this section: (1) acceptable design of hydraulic structures and (2) flood avoidance by minimizing storm water generation.

Flooding is the absence of necessary freeboard during high-flow conditions such that structures (e.g., roadways, buildings) are put at risk because they or their foundations come into contact with water. Flooding could occur within a newly constructed area because of insufficient conveyance capacity of nearby structures (e.g., undersized culverts, culverts temporary plugged by ice), or they could occur downstream of newly constructed areas because of increased storm water runoff originating from new impervious areas. Both flood conditions are discussed in this section. At the end of the section, recommendations from the EPA regarding potential flood control criteria are made available for communities that are considering establishing/revising their storm water ordinances.

Alaska designers might have to evaluate a design flow, a check flow and an extreme event flow when designing hydraulic structures. Consider the following examples (designers should check with the appropriate agency for specific design criteria):

- Design flows—a culvert passing the 10-year flow with a minimum of 1 foot of freeboard
- Check or Review flows—a culvert passing 25-year flows without damage to the road crossing
- Extreme Events—no flooding of stream-side buildings because of performance of the culvert

One source of information available to Alaska designers on the hydraulic design of structures is ADOT&PF, which provides guidance for Alaska roadways. As a result, the ADOT&PF guidance is universally applicable to Alaska (unless superseded by local ordinance), and many flooding events involve roadways or roadway crossings.
Table 3-6 contains some current ADOT&PF design criteria. It is recommended that designers outside of Alaska urban centers consider the recommendations made by ADOT&PF. However, it is also recommended that designers consider not just the current upstream hydrology, but what the hydrology will be at *build-out* (i.e., the expected

post-developed scenario). For urbanizing areas, the build-out flow rates will exceed flow rates derived from current upstream land use by substantial amounts.

Table 3-6. ADOT&PF hydraulic design criteria for various structures

Type of structure	Return period (exceedance probability)
Culverts in Designated Flood Hazard areas*	100 years (1%)
Culverts on Primary Highways	50 years (2%)
Culverts on Secondary Highways with high D.H.V.'s or providing Sole Area Access	50 years (2%)
Culverts on Secondary Highways of less importance	10 years (10%)
Channel Changes in Designated Flood Hazard Areas	100 years (1%)
Channel Changes along Primary Highways & important Secondary Highways	50 years (2%)
Channel Changes along less important Secondary Highways	25 years (4%)
Trunk Storm Sewers Lines on Primary Highways	50 years (2%)
All other Trunk Storm Sewer Lines	25 years (4%)
Storm Sewer Feeder Lines	10 years (10%)
Side Ditches, Strom Water Inlets and Gutter Flow	10 years (10%)
Side Ditches, Strom Water Inlets and Gutter Flow in Depressed Roadway Sections	50 years (2%)
Bridges in Designated Flood Hazard Areas*	100 years (1%)
Bridges on all Highways	50 years (2%)
Scour at Bridges, Design	100 years (1%)
Scour at Bridges, Check	1.7 × 100 years or 500 years (0.2%)

* Unless local ordinance requires a greater design frequency.

Source: ADOT&PF 1995. *Alaska Highway Drainage Manual*, Chapter 7. (see Web Link 47 in Appendix A)

Alaska designers may be required by local ordinances to limit the peak runoff rates from new development sites. This requirement may be based on a design rainfall event (e.g., 10-year, 24-hour event), where the peak post-development runoff rate cannot exceed the estimate predevelopment runoff rate. Where this is the case, the interaction of storm water BMPs with the flood-prevention requirement should be discussed in the design of the permanent BMP and in the construction storm water pollution prevention plan if the project is in MOA.

As discussed in Chapter 2, designers are faced with the potential that snowmelt during the spring breakup might be more critical than rainfall for sizing hydraulic structures. There are no statewide requirements; however, it is recommended that designers consider the approach taken by MOA that uses a snowmelt event of approximately 5-year recurrence interval in all parts of Alaska other than the Coastal Climatic Region (see Web Link 41 in Appendix A).

Many local communities in the lower-48 states require that the first fraction of runoff be managed to minimize storm water pollutants and bypassing any additional flow into a flood-management BMP. The flood-management BMP also provides some level of stream protection because it tends to attenuate discharge rates and reduces high rates of stream bank erosion.

This treatment train approach, whereby a series of BMPs are used to meet combined water quality and quantity objectives, can also be used to provide flood protection for downstream areas. Without such controls, flood flows can multiply as new construction sites blossom along stream corridors, resulting in more frequent and more sustained flooding of downstream structures. In some cases in the lower-48 states, buildings over a century old suddenly begin to experience regular flooding because the upstream watershed converts into urban land use.

For communities evaluating creating or changing their storm water ordinance, Table 3-7 lists EPA's recommendations and considerations:

Table 3-7. Recommended flood protection standards

Design Recommendations for Overbank Flood Protection
The postdevelopment peak rate of discharge for the 10-year, 24-hour storm should be reduced to the predevelopment peak rate.
New structures or crossings within the flood plain shall have adequate capacity for the ultimate (build-out) condition.
Nuisance flooding that damages downstream property and infrastructure should be minimized.
Extreme Flood Control
The postdevelopment peak rate of discharge for the 100-year, 24-hour storm should be reduced to the predevelopment peak rate.

Adapted from Hirschman and Kosco 2008

Control criteria are reasonable to avoid costly over-control of peak rates that has marginal downstream benefits. In light of this, communities considering a new flood prevention ordinance might permit waivers for the following conditions:

- Discharges to large waterbodies
- Small construction sites (< 5 acres in size)

- Some redevelopment projects (e.g., where site size is small, where historic preservation limits modification, where site geometry/topography make the installation of peak runoff control devices impracticable)
- Sites subject to a flood plain study that recommends alternate criteria
- Sites where on-site detention will cause a downstream peak flow increase from predevelopment levels because the peaks from the site and watershed coincide.
- Subject to applicant justification and local jurisdictional approval

Accepted Modeling Software or Analytical Approaches for Assessing Flood Potential

Alaska designers can choose from an array of accepted mathematical models for estimating flooding potential, including HEC modeling software, including HEC-RAS. Other methods to consider include peak flow estimation techniques (regression equations (USGS Report WRI 03-4188); Soil Conservation Service methods if evaluating small basins (TR-55 or EPA SWMM)) coupled with site topography and flood routing analysis.

3.3.5 Low Impact Development/Environmental Site Design

Various types of green-building, smart-design, or low-impact building options exist for land developers. Herein, these are collectively referred to as LID, although a suite of technical and trade names exist for the same basic concept. Collectively, LID uses a broad collection of storm water BMPs that can help designers implement storm water management requirements, provide fiscal and environmental benefits for future land owners and reduce development costs. Potential advantages of LID to designers in Alaska are the following:

- Helps meet treatment requirements for the water quality volume
- Reduces impervious surfaces (roadways), curb, and gutters
- Decreases the use of storm drain piping, inlet structures
- Eliminates or decreases the size of large storm water ponds

Designers should note that LID is a design concept that can be employed to manage all or part of the storm water quality volume discussed in Section 3.3.1. It also has the advantage of reducing channel protection needs and drainage/flooding issues by helping to retain the predevelopment hydrology.

LID is new to Alaska, and local communities are still determining which concepts are acceptable or applicable and when they could serve as alternatives to more conventional permanent storm water management controls. The LID concepts that have the highest potential in Alaska are the following:

- Retaining existing or native vegetation
- Reducing directly connected imperviousness
- Reducing curb and gutter and using vegetated swales
- Allowing on-site infiltration for high infiltration areas
- Optimizing development to cluster structures
- Preserve high-quality land or highly sensitive land

As can be inferred from the above list, LID as applied to Alaska focuses on reductions in summertime storm water runoff generation and on-site treatment (where appropriate). When preparing drainage designs and engineering plans for review under 18 AAC 72.600, note the areas of the site where reductions in runoff volume will occur because of less runoff being generated, and where runoff is directed onto high infiltration areas.

In addition, there is a potential to employ LID treatment technologies, such as biofiltration with vegetated swales. Biofiltration has been reviewed by MOA, which has prepared a guidance document on its application, titled *Guidance for Design of Biofiltration Facilities for Stream Water Quality Control* (see the Web Link 48 in Appendix A). Also, see MOA efforts to introduce rain gardens at the Web Link 49 in Appendix A.

Information Sources Related to LID for Alaska Designers

Resources are available to Alaska designers that will help in evaluating of LID or environmentally friendly design. Alaska weather and soil conditions offer special challenges that can be evaluated only on a case-by-case basis; however, the suite of models, calculators and tools available from EPA (see Web Link 50 in Appendix A), offer benefit for developers interested in green building. See *Low-Impact Development: An Integrated Design Approach*, June 1999 at Web Link 51 in Appendix A.

LID application to cold-climate states is progressing in the lower-48 states. The Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET), in coordination with the University of New Hampshire Stormwater Center (UNHSC) completed a cold-weather study of LID, the findings of which call into question widely held assumptions that runoff management measures employing filtration, vegetation and natural chemical and microbial processes are ineffective during sub-freezing winter weather. Interested readers can access the study results (which include installation costs and maintenance requirements) at the Web Link 52 in Appendix A.

3.4 Storm Water Situation Considerations

3.4.0 Introduction

This section presents a variety of situations encountered in Alaska that warrant special consideration when selecting or designing storm water controls. Because these situations could occur anywhere in the state, the following discussion is generalized and, therefore, does not differentiate among the climatic regions in Alaska. Adaptation of this guidance to specific conditions is recommended.

3.4.1 Storm Water Strategies for Urban, Suburban and Rural Areas

Alaska development differs greatly in its scale and intensity, and individual communities need to craft their local storm water criteria to reflect these differences. Three broad categories of development intensity are considered in this section—rural, suburban and redevelopment. *Rural* forms of development are loosely defined as low-density development that generally is outside MS4s and coastal communities. Most frequently, the development occurs in boroughs with less urbanized development and might not be subject to local engineering review because of a lack of local capacity. New *suburban* development frequently is within the boundaries or at the margins of MS4s and coastal communities. Storm water compliance is easier at such *greenfield* sites because designers have more flexibility in site layout, and a local land development review process may exist.

Redevelopment occurs within the core of larger MS4s and coastal communities and frequently involves infill and redevelopment. Storm water compliance at redevelopment sites is often more difficult because of small project size, space and soil limitations, high land prices and constraints imposed by the existing storm water conveyance system. In addition, many storm water treatment practices that work effectively in rural and suburban watersheds, might not be as feasible at redevelopment sites (e.g., large ponds and wetlands, filter strips, grass channels).

Because of inherent differences in cost, feasibility and review capacity, it is recommended that localities customize their storm water criteria to reflect where development occurs (rural, suburban and redevelopment areas), as described below.

Options for Rural Development. The primary approach to improve compliance in more isolated rural development is to shift away from detailed engineered storm water site plans to general residential storm water plan with standard conditions for nonstructural storm water practices. Examples of some of the standard conditions for rural development might include the following:

- Maximum limits on the amount of impervious cover for the site (e.g., 15 percent)
- Maximum limits on the footprint of the site which is cleared and graded (25 percent)
- Minimum limit for preservation of wetlands, native cover and other conservation areas protected by a perpetual conservation easement
- Minimum standards for dirt or paved road construction to prevent erosion
- Temporary stabilization and perimeter sediment controls during construction
- Fixed widths for stream, wetland and shoreline buffers, if needed
- Standard methods to disconnect and treat rooftop runoff over a suitable pervious area
- Use of grass channels or swales to convey concentrated runoff from the site
- Other standard measures to prevent or reduce runoff from the site

The advantage of this approach, which has been used in several states, is that it sharply reduces the cost of preparing and reviewing detailed engineering plans, while still providing maximum use of nonstructural storm water practices that can be shown on standard construction drawings. Designers and contractors would be subject to enforcement actions if they fail to meet the standard conditions. The local and state storm water review agency may still retain the authority to require engineered storm water plans for larger or more intense development projects in rural areas and projects that discharge to the state highway system.

Options for Redevelopment. Redevelopment is at the other end of the intensity spectrum and creates a storm water management paradox. On one hand, stringent storm water requirements can ensure that incremental pollutant reductions are made within existing urban watersheds, which are frequently impaired by past land development, and might not meet water quality standards. On the other hand, stringent storm water requirements can drive up compliance costs, and become a disincentive for compact smart growth. Communities that have chosen a balanced approach could involve one or more of the following options:

- Define redevelopment in their storm water ordinances through some combination of minimum land area or improved property value such that minor projects are not subject to the water quality volume (WQv).
- Eliminate the WQv requirement for redevelopment sites where a 20 percent or greater reduction in post-development impervious cover (IC) is achieved through site redesign.
- Reduce the redevelopment WQv requirement to 20 to 50 percent of the *greenfield* WQv.
- Maintain the same WQv as in greenfield settings, but allow developers to pay an IC mitigation fee for any unmet WQv, which is set at the average compliance cost in a greenfield setting.
- Eliminate the WQv requirement for redevelopment sites, but charge an impervious cover mitigation fee that is used to design and construct regional storm water and restoration projects elsewhere in the community.

3.4.2 Linear Projects

Linear projects (e.g., roads, pipelines, utilities) are projects that cut across topographic features, most notably streams, valleys and ridgelines. In many cases, these projects are many miles long, although they might only be 100 feet at their widest. As a result of their geometry, storm water discharge points are dispersed all along the project, and the discharge might be on only one side of the project. In locations with strong cross-slopes (e.g., cut banks), culverts might be required to pass storm water under the project pathway. Depending on project location and geometry, storm water might concentrate only where valley slopes lead to roadside swales or at stream crossings. Designers of linear projects in Alaska are likely to face high variations in soils and could encounter wetlands and steep slopes in a single project.

The Federal Highway Administration (FHWA; see the Web Link 53 in Appendix A) suggests the suite of storm water borne pollutants from roadways includes the following:

- Oil and petroleum
- Trash/litter
- TSS (from areas eroded because of impervious surface erosion)
- Chemical applied during winter conditions (e.g., salt and grit)
- Thermal pollution caused by the runoff contacting and flowing over relatively warm pavement

Depending on the material being transported, pipelines can also generate some of or all the pollutants mentioned above. Pipeline projects might have additional storm water risks associated with either endemic leaks or catastrophic failures of the completed pipeline.

Linear projects also can have impacts because of physical changes of hydrology and hydraulics. Hydrologic changes commonly encountered originate from impulse discharges from impervious surfaces (e.g., pavement). High flow rates from either rainfall or rapid snowmelt can increase erosion potential, particularly where steep slopes abut excavation/road cuts.

Some common management challenges that designers might face are the following:

- Designing, installing and maintaining numerous relatively small BMPs that serve only a fraction of the whole project area
- Operating within space limits (e.g., placing BMPs within right-of-way limits)
- Dispersing storm water flow evenly into road-side grassed areas where topography is flat (e.g., less than 2 percent)
- Ensuring safe travel during wintertime conditions (snow plowing, applications of anti-skid abrasives)
- Ensuring access to maintain BMPs while minimizing unintended entry and use by the general public
- Using the BMPs with the lowest maintenance costs, while ensuring that they will perform for a long project life

There are a number of approaches to face the challenges and facilitate storm water management for linear projects:

- Use sod-forming grasses adjacent to roadway shoulders and for vegetated swales to serve as filters for suspended solids and metals
- Limit the use of curb-gutter sections as much as practical for filtering and thermal pollution control (to give the runoff an opportunity to infiltrate as quickly as practical)
- Consider including infiltration berms and retentive grading in areas that are down slope of the roadway/pipeline.
- Select and use winter maintenance materials to minimize environmental impacts
- Consider porous pavement and other subsurface infiltration methods where natural soils and topography favor such methods

- Look for opportunities to use extended detention BMPs and constructed wetlands to maximize retention times

Linear project designers should consult these resources:

- ADT&PF provides a wide range of reference documents that include engineering requirements/minimum standards applicable to roadways at the Web Link 54 in Appendix A.
- Green Highway Partnership provides case studies and reviews innovative technologies applicable to linear projects at the Web Link 55 in Appendix A.
- Evolving environmental developments at American Association of State Highway and Transportation Officials (AASHTO) at the Web Link 56 in Appendix A.
- Evolving environmental developments at FHWA at the Web Link 57 in Appendix A.

3.4.3 Spatial Projects (e.g., malls and high-density subdivisions)

Shopping malls and apartment/condominium developments are examples of spatial projects. Typically they range in size from 5 to 20 acres, a large portion of which are made up of impervious surfaces (e.g., roofs, roadways and parking areas). In general, the site geometry is targeted to optimize transportation/ parking/ building placement and to meet vehicle egress requirements. Often available open space is limited in the effort to maximize the commercial return on the developing area.

Hydrologically, the high levels of imperviousness generate high rates of storm water flow per acre. Concentrated flow generated from roadway/parking and roof areas flow through efficient conveyance systems (either below-grade storm water pipelines or in roadside gutters), and there is a strong tendency to have a relatively few discharge points. In addition, large volumes of snow have to be managed during wintertime to ensure movement of people and vehicles. For malls/shopping areas, snow removal is typically contracted out to a snow removal company, while high-density subdivisions have public plowing or private snow removal.

Pollutants of concern commonly associated with spatial projects include the following:

- Trash (e.g., plastic bags, paper litter)
- Oil and petroleum dripped from motor vehicles
- TSS
- Nutrients (e.g., fertilization of green areas)
- Thermal pollution caused by the runoff contacting and flowing over relatively warm pavement

Spatial projects significantly change the hydrology and hydraulics of a location, and usually create maintenance issues (e.g. stream bank erosion) if proper management is not employed. The hydrologic changes commonly encountered originate from impulse discharges from impervious surfaces (e.g., pavement). It is not uncommon to triple the total volume of storm water generated from the spatial project land area, as compared to predevelopment volumes from grassed/forested settings. Efficient conveyance systems rapidly concentrate flows but provide centralized locations where it is possible to attenuate storm water flows. In Alaska, high flow rates from spatial projects could be from rainfall or rapid snowmelt.

Some common management challenges that may face designers are as follows:

- Integrating the management to mitigate multiple issues (e.g., linking trash/litter management with snow removal, while operating BMPs that manage storm water volume and water quality)
- Ensuring safe travel during wintertime conditions (snow plowing, applications of anti-skid abrasives)
- Ensuring that consistent maintenance is provided to *shared* BMPs or BMPs that service multiple entities (e.g., multiple stores sharing a parking lot)
- Ensuring access to maintain BMPs while minimizing unintended entry and use by the general public

There are a number of approaches to face the challenges and facilitate storm water management for spatial projects:

- To the extent practical, minimize impervious cover when establishing the site design
- Look for opportunities to maximize vegetative cover, either by retaining existing natural cover or by planting tolerant plant species
- For improved cold weather operations, consider design techniques for ponds and wetlands operated in a seasonal mode, which can be found in Chapter 9 of the *Minnesota Stormwater Manual* (MSSC 2005)
- Consider using constructed wetlands, which are in *Evaluation of Stormwater Treatment in Constructed Wetlands in Alaska*. (FHWA 2004)

Resources are available to facilitate the design of spatial projects and often promote approaches that minimize storm water costs while improving the performance of permanent storm water BMPs. As parking areas generally compose a significant portion of spatial projects, designers are encouraged to consult a recent publication from the MOA regarding parking lot BMPs (*Anchorage Parking Lots: 2002 Best Management Practices Guidance*), at the Web Link 58 in Appendix A.

The MOA guide provides a wide range of design and maintenance criteria for designers of spatial projects, too numerous to provide in their entirety in this document. The CWP has generated a wide range of literature to facilitate better designs for spatial situations. For information to help identify opportunities for narrower roads, smaller parking lots, rooftop disconnection, cluster lots and other better site design techniques, see the CWP Web site at the Web Link 59 in Appendix A.

3.4.4 Mining Considerations

Mining can be grossly classified as surface mining, underground mining, and in situ mining. Surface mining, used to excavate ores at or close to the earth's surface, includes open pit mining and highwall or strip mining used to excavate coal or other deposits as well as dredging to excavate placer deposits. Surface mining usually results in the most significant storm water impacts. In some mining districts, widespread stream disturbance by placer mining or dredging could be present along with other disturbances from underground mining or mineral processing. Placer mining is still an important industry in Alaska, and some abandoned, large-scale dredge operations remain. In some cases, the dredges are still present in the dredge ponds created as part of the operation. Underground and in situ mining remove minerals from deeper deposits. Underground mining extracts and removes ores from beneath the surface and in situ, consists of sinking injection and extraction wells and then leaching the ore in place to extract the minerals.

A common theme among environmental problems associated with *active mining* operations and mine wastes is contamination of all media, including groundwater, soil, sediments, and surface water. Contamination can result from a host of metals, primarily Arsenic, Cadmium, Copper, Manganese, Molybdenum, Lead, and Zinc and a wide variety of sources (e.g., acid drainage and sulfide bearing waste piles, exposed ore zones, heap-leach spoils, mine-waste piles and sediments, slag piles, fluvial tailings deposits, and tailings and waste rock piles).

Generally, pollutants of concern from *abandoned mines* are sedimentation of Surface Waters, acid drainage and contamination of ground and surface waters with metals, including cyanide. Many mine sites suffer from the uncontrolled discharge of acidified water, which becomes contaminated as it flows through abandoned mine workings.

For large mines in Alaska, there are a series of state and federal permits required before mining activities can begin that are intended to limit the effects of mining activities on the environment. For details of the permits that are required, see ADNR's Office of Project

Management and Permitting Web site at Link 60 in Appendix A. Under state law, a mine operator must develop a *Plan of Operations* for mine development and have it reviewed and approved by the ADNR. An operator must also prepare a *Reclamation Plan* for rehabilitating or *reclaiming* the mine site when mining operations end. The plan must include an accounting of all costs associated with reclamation. This then forms the basis for negotiations with ADNR for determining a bond requirement that will ensure that sufficient funds are available to close the mine when operations end and reclaim the mine area to standards set in state law.

The objectives of reclamation typically include stabilizing and protecting soil and exposed overburden materials from wind and water erosion. Stabilizing steep slopes can be accomplished through contouring and leveling to provide rounded land forms and suitable seedbeds. Establishing long-term, self-sustaining vegetation is best accomplished through reseeding and promoting natural invasion and succession. The intent of achieving the objectives is to return reclaimed sites to a stable and environmentally sound condition that meet the designated land uses.

3.4.5 Cold Climate Considerations

This section reviews more specific techniques to maintain the effectiveness and longevity of erosion controls, storm water practices and snow storage areas throughout the demanding winter months so they are ready to function during the spring melt.

Note: For a more detailed description of winter construction and snow storage and disposal control measures issues, see CWP's *Cold Climate Manual* at Web Link 61 in Appendix A and see the specific situations included in Section 2.6.

Winter and the Design of Erosion and Sediment Controls

Winter conditions impose extreme challenges at construction sites and make it difficult to install and maintain many of the common erosion and sediment control (ESC) practices used during the growing season (see Table 2-10). Therefore, communities might consider defining a calendar period for winter shutdown at construction sites (e.g., October 15 to April 15). The actual dates for the shutdown window will be different in each of the major climatic zones of Alaska. In some cases, construction might need to extend past the winter shutdown date or winter construction might be preferable, in which case, special erosion control requirements apply to the sites.

Because the onset of winter changes from year to year, designers and contractors need to be mindful of how to prepare their sites for the winter, regardless of the exact date for winter shutdown. They also need to carefully consider how to maintain ESCs during the winter and how to restore the controls' ability to handle sediment discharges when construction resumes at the onset of spring.

The following suggestions are offered on how to provide ESC during the winter months, which have been adapted from MSSC (2005), NHDES (2008) and VTDEC (2006). Localities could choose to modify these suggestions according to their unique climate and site conditions.

Activities before Winter Shutdown. Contractors need to start thinking about winter operations several months before the winter shutdown date. For example:

- Temporarily or permanently seed all exposed soils before the winter shutdown.
- It is recommended that seeding occur at least 30 days before the winter shutdown date to assure germination and adequate growth before cold conditions prevent effective cover (NHDES 2008). Designers should consult Wright (2008) on the most suitable grass species for temporary stabilization in the different climatic regions of Alaska.
- Contractors should inspect seeded areas to ascertain the condition of vegetative cover and repair any damaged areas or bare spots and reseeded as required to ensure that a threshold of at least 70 percent of vegetative cover is achieved.
- All grass-lined channels should be installed and stabilized at least 45 days before the winter shutdown date.

Actions at Winter Shutdown. It is recommended that contractors sequence their work so that all major earthwork and soil disturbance occurs before winter shutdown, and they should carefully track weather conditions so that they can shut down the site before the ground freezes. The following actions are recommended:

- Stabilization should be completed within a day of establishing the grade that is final or that will otherwise exist for more than 5 days. Stabilize all exposed soil surfaces with mulch or synthetic cover before the ground surface freezes and sprays become inoperable.
- All areas that do not meet the 70 percent vegetative cover threshold by the winter shutdown should be seeded and covered with appropriate erosion control covering such as rolled erosion control blanket or bonded fiber matrix. Installing erosion control products is not recommended if the snow depth is greater than one inch.
- If 70 percent vegetative cover is not attained in grass-lined channels before shutdown, the channel should be stabilized with stone or erosion control blankets appropriate for design flows, as determined by a qualified erosion control specialist.

- Ensure that perimeter controls are installed around the site and make sure they are firmly anchored. If frozen ground prevents their use, use sand bag berms or other temporary perimeter controls instead.
- Establish stable ingress/egress points and stockpile gravel on-site to maintain the routes during the winter season. Install roads to keep vehicles and construction equipment off of exposed soils. Incomplete road or parking areas where active construction has stopped for the winter season should be protected.
- Stockpiles of soil materials should be mulched over for over-winter protection at twice the normal rate of a 4-inch layer of erosion control mix. Mulching should be done within 24 hours of stocking and be reestablished before rainfall or snowfall.
- Frozen materials (e.g., permafrost or frost layer removed during winter construction) should be stockpiled separately. No frozen soil stockpile may be within 100 feet of any wetland or water resource area. Stockpiles of frozen materials can melt in the spring and become unworkable and difficult to transport because of high moisture content.

Maintenance during Winter Shutdown. It is recommended that erosion control measures be checked at the end of winter to ensure they are ready to handle spring snowmelt. After each winter rainfall or snowmelt runoff, contractors should inspect all installed erosion control measures and perform repairs as needed to ensure their continuing function. Specific winter maintenance measures include the following:

- Minimize any new soil exposures and stabilize them immediately
- Inspect perimeter controls monthly throughout the winter to ensure their structural integrity
- Use sandbags or other measures to repair damaged silt fence when frozen ground makes driving posts infeasible
- Maintain a stockpile of sandbags, erosion blankets and gravel on-site to address problems that need immediate attention

Winter Construction Requirements. In some circumstances, construction might need to extend past the winter shutdown date, in which case, it is recommended that the following measures be included into the ESC plan:

- Site access points should be enlarged and stabilized to enable snow stockpiling.
- Modify the limits of disturbance to reflect the smaller boundary of the winter work, if applicable.

- Where practicable, provide a minimum 15-foot-wide buffer around all perimeter controls to prevent damage from snow clearing or a 25–foot-wide buffer from snow storage areas.
- Double the standard rate of mulch application on exposed soils during winter construction.
- Generally, the exposed area should be limited to only those areas in which work will occur in the following 15 days and that can be mulched in one day before a rainfall or snowfall event.
- Exposure of subsequent work areas is not recommended until the previously exposed work area has been fully stabilized. An area is considered *exposed* until stabilized with gravel base on a road or parking area, pavement, mulching, erosion control mix, erosion control mats or riprap.
- Sediment barriers that are installed during frozen conditions should consist of erosion control mix berms, continuous contained berms (see Section 4.3 of Volume 3 of NHDES (2008)) or sand bag berms.
- Installing erosion control blankets is not recommended on frozen ground or if more than one inch of snow is present.

Reestablishing ESCs in the Spring. The risk of high sediment discharges are greatest in the spring when vegetative cover is not yet established and snowmelt runoff occurs. The following practices are recommended:

- Contractors conduct weekly (or more frequent inspections) to ensure the integrity of ESC practices
- Immediate repair to damaged perimeter controls and cleanout of recently deposited sediments from traps and basins
- Stabilize any exposed soils with a thick cover of mulch or ESC product within 14 days

Snow Storage and Disposal Controls

Good site management and good housekeeping practices includes a plan for where excess snow from plowed roads and parking lots will be stored and disposed of after the site is fully constructed. In residential areas, snow is allowed to be plowed to the side of the road and accumulates throughout the winter. In more intense commercial and industrial areas, however, snow is dumped into large piles either on-site or removed to an off-site area. Good site management for snow storage or dumping includes the following options:

- Collect the snow on an impervious pad and divert the meltwater for treatment.
- Collect the snow on a flat slope well away from surface waterbodies, outside the floodplain and well above the seasonally high water table.
- Collect the snow on a well-drained pervious area where it can gradually melt and infiltrate into underlying soils. These pervious areas can include turf or lawn areas, landscaping areas, or within portions of selected storm water treatment practices, as long as snow dumping will not harm any trees or shrubs that have been planted.
- Avoid storing snow in locations where it can run off to adjacent wetlands or high-quality streams.
- If snow storage routinely occurs, the storm water maintenance plan should require an annual cleanup in the spring to remove sediment and debris and perform spot reseeding, if needed.

Cold-Climate Design of Permanent Storm Water Controls

Several basic design principles can improve the performance and longevity of storm water treatment practices installed in cold climate regions (Caraco and Claytor 1997; MSSC 2005; VTDEC 2006; NHDES 2008).

- Select the types and designs of storm water treatment structures that work well in the soil and climate conditions in your region of Alaska (for guidance, see Table 2-9 and Chapter 4)
- Use multiple cells in treatment practices and oversize the first pretreatment cells to account for high sedimentation rates
- Check to see if road salt or deicers are likely to be used in the contributing drainage area to the practice. If so, choose salt-tolerant grass, wetland, shrub and tree species to maintain vegetative cover
- Design practices to operate in a two-stage seasonal mode so that water levels can be drawn down before winter so that the practice has extra capacity in the spring to accommodate extra meltwater

- Avoid draining ponds during the spring because temperature stratification and high chloride levels can discharge acidic or anoxic water downstream
- Do not submerge inlet pipes into permanent pools to avoid causing pipe ice blockages that could damage pipes or cause upstream flooding
- Slope inlet pipes so that they have a minimum slope of 1 or 2 percent to prevent standing water that could freeze
- Avoid infiltration where permafrost exists
- Place underdrains and outlet pipes at least a foot below the frost line, and increase their diameter by at least one pipe schedule
- When perforated pipes are used, the minimum opening diameter should be one-half inch, and they should have a minimum pipe diameter of at least 6 inches
- Angle trash racks to prevent ice formation
- Modify maintenance agreements to specify an annual springtime maintenance inspection of storm water practices to assess whether cleanups or repairs are needed to maintain their function
- Soil or sand filter beds should extend below the frost line, and in general, avoid using peat and organic media because they retain water and are likely to freeze
- Use broad, multiple cell swales for surface treatment rather than underground pipes
- Use the zero-order drainage network as a prime location for shallow, multi-cell, forested wetlands (CSN 2009)

More specific design guidance is provided for individual storm water treatment practices in Chapter 5 of this manual.

3.4.6 Pulling It All Together: Choices in Local Storm Water Design Manuals

The statewide storm water manual presents a broad framework for making the best possible storm water decisions, but localities will still need to make careful choices on how to adapt and interpret this framework in the context of their local climate, terrain and development conditions. In addition, localities will need to provide more detail on how storm water will be handled in their local development review process, including measures for design submittal, construction inspection, facility acceptance and maintenance. An excellent resource for developing local storm water guidance is in *Managing Stormwater in Your Community: A Guide for Building an Effective Post-Construction Program* (Hirschman and Kosco 2008).

These choices can then be incorporated into local storm water ordinances, policies and design guidance. The following checklist outlines some of the specific decisions that Alaska communities need to make when building their local storm water programs:

- Analyze local, long-term rainfall and snowmelt data
- Define your local sizing criteria for the water quality volume and other storm events
- Define the calendar dates by which special winter construction and ESCs will be required
- Determine the range of acceptable storm water treatment practices
- Define any cold-weather modifications for standard storm water and ESC practices
- Determine whether your community will need to include special criteria for rural or redevelopment projects that might occur in the future
- Determine if any additional land uses or future operations will be designated as storm water hotspots
- Define the stages in local land development review process that storm water plans must be considered (e.g., initial concept plans, final engineering plans and any required coordination with other local or state environmental permits)
- Determine standard submittal requirements and develop plan review, construction and maintenance checklists to streamline project review
- Determine the model for maintenance responsibility in the community (public, private or hybrid) and minimum requirements for BMP tracking and inspection
- Develop standard storm water easements, maintenance agreements, performance bonds and impervious cover mitigation fees
- Encourage LID