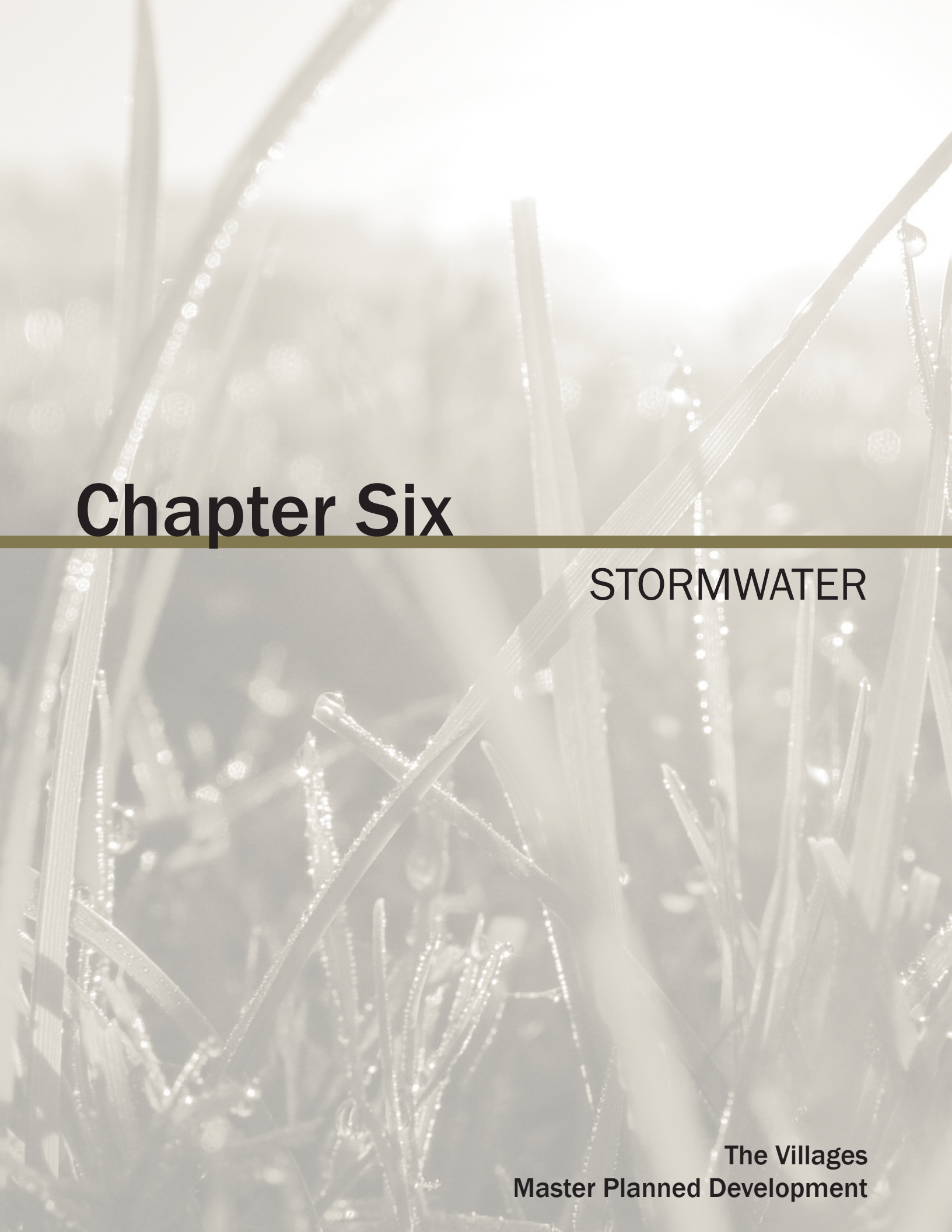


Chapter Six

STORMWATER

The Villages
Master Planned Development

6

CHAPTER

OVERVIEW

The purpose of the stormwater section is to describe the overall stormwater goals for the site, describe the stormwater concept for the entire site, and provide standards for stormwater management at the development parcel level to ensure the overall goals are met.

Stormwater for The Villages MPD is managed through collection, treatment and release into groundwater or surface water bodies. Large areas of The Villages site are suitable for infiltration of stormwater to groundwater (aquifers) using Low Impact Development (LID) techniques, therefore infiltration is a key component of the stormwater management plan. Where feasible, stormwater is proposed to be infiltrated to either the shallow outwash soils (Qvr) that form a shallow aquifer or to deeper outwash deposits (Qpog) that form a deep aquifer underlying the site. Since some areas are sensitive to changes in water volumes or are not suitable for infiltration, more traditional stormwater management techniques are also necessary. Thus, the components of the stormwater management plan for the site include infiltration of stormwater into the shallow aquifer (Qvr) through LID, infiltration into the deep aquifer (Qpog) through infiltration facilities, conventional ponds, wetland recharge, water quality treatment facilities and regional stormwater management facilities.

Facilities to serve the entire development have been planned and approximate locations determined (See Figure 6-1). There will be regional stormwater facilities on the site which will infiltrate into the deeper outwash deposits (Qpog). One of the regional stormwater facilities will be used to treat the excess stormwater created by the need for water balance to Horseshoe Lake. The second facility will treat and infiltrate the excess stormwater created by the need for water balance to the aquifer above the steep slopes south of the site, Black Diamond Lake, and the wetlands on the southern portion of the site. These facilities may be replaced with a single large offsite facility.

In addition to these regional facilities, additional facilities will be needed to manage stormwater for each development parcel. These facilities will be designed with the construction plans for each implementing plat consistent with the standards provided in this plan. Since stormwater management needs, treatment options, and discharge options vary across the site, the site has been divided into stormwater management zones based on groundwater flow paths, soil types, topography, and surface water features. Each zone has stormwater requirements specific to its unique conditions. Each development parcel will be required to manage stormwater consistent with the standards for the stormwater management zone within which it is located.

STORMWATER MANAGEMENT GOALS

The overall goals of this stormwater management plan are as follows:

- Maintain surface water and groundwater quality and quantities consistent with the requirements of the Department of Ecology's 2005 Stormwater Manual for Western Washington;
- Avoid impacts to Horseshoe Lake water levels by ensuring that the volume of stormwater infiltrated into the shallow outwash upgradient of Horseshoe Lake is approximately the same as that which infiltrates under predeveloped conditions;
- Avoid impacts to water quality in Lake Sawyer by providing stormwater treatment that treats for phosphorus removal for those basins that drain to Lake Sawyer;
- Maintain hydrology for Black Diamond Lake and wetlands on the site by recharging them with approximately the same volume of stormwater as would occur under predeveloped conditions;
- Maintain pH levels and water quality in Black Diamond Lake;
- Avoid impacts to steep slopes by routing excess stormwater away from slopes to a stormwater management facility;
- Recharge groundwater with stormwater infiltrated using Low Impact Development techniques and infiltration facilities; and,
- Provide a menu of stormwater treatment options ranging from ponds to rain gardens.

2005 STORMWATER MANUAL FOR WESTERN WASHINGTON

This stormwater management plan has been prepared to meet the requirements of the Department of Ecology, 2005 Stormwater Management Manual for Western Washington (DOE Manual). This plan assumes that the City of Black Diamond will adopt the 2005 DOE Manual. The DOE Manual requires the following:

- The duration of stormwater discharge in the developed condition must match predeveloped durations for the range of predeveloped discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow (Minimum Requirement #7: Flow Control);
- Basic water quality treatment for stormwater generated by residential development;
- Enhanced water quality treatment for stormwater generated from commercial development, multi-family development and roads with Annual Average Daily Traffic (AADT) above 7,500, except when that stormwater is infiltrated to groundwater more than ¼ mile upstream of fish-bearing waters; and
- Phosphorus treatment for stormwater released to surface waters that ultimately drain to Lake Sawyer.

KEY STORMWATER MANAGEMENT ISSUES

The following issues have been identified as important and are addressed through the stormwater management plan and design of the overall stormwater system for the project.

HORSESHOE LAKE

Horseshoe Lake lies directly west of The Villages site and under existing conditions has occasional flooding problems. Based on groundwater studies completed for the project, these flooding problems appear to be the result of high ground water levels within the shallow aquifer that feeds the lake. The groundwater recharge area for this aquifer and Horseshoe Lake extends under a portion of The Villages site.

Development of The Villages site and the conversion of ground cover from existing forested conditions to impervious surfaces will result in an increase in the volume of stormwater produced. Typically, on a site which can accommodate infiltration, the DOE Manual allows for all stormwater to be infiltrated, even though an increase in volume occurs. Since an increase in volumes over existing volumes could exacerbate Horseshoe Lake flooding, this plan requires infiltrated volumes to approximately match volumes under existing conditions.

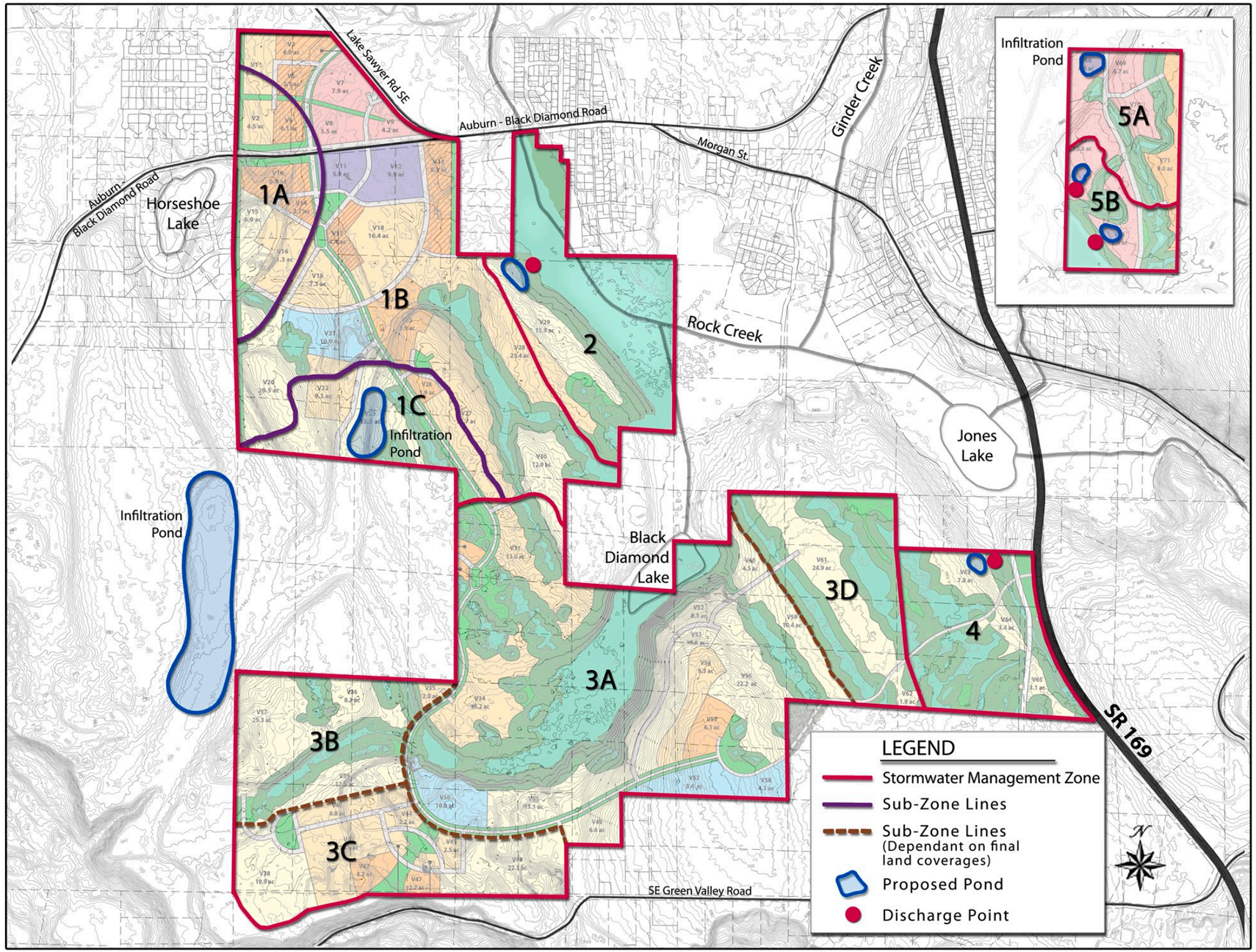
Specifically, the stormwater management standards require that the volume of stormwater infiltrated within the groundwater recharge area tributary to Horseshoe Lake match volumes under existing conditions. Excess volume is proposed to be conveyed to a regional stormwater facility which infiltrates to the deep outwash aquifer, bypassing Horseshoe Lake. Stormwater still needs to be infiltrated into the shallow aquifer to maintain existing hydrology of Horseshoe Lake and thus maintain existing lake levels. The bypass of the excess volume will mitigate impacts of development to the Lake's existing flooding problems.

STEEP SLOPES AND DOWN GRADIENT WELLS

The Villages site contains a portion of the recharge zone for the ground water table that is the source for down gradient wells and slopes south of the site. A portion of the stormwater will be infiltrated in this recharge zone in order to maintain subsurface flow to these existing wells. Stormwater in excess of the water balance necessary to maintain the down gradient wells will be conveyed to a regional stormwater facility to avoid impacts to the steep slopes south of the site.

BLACK DIAMOND LAKE

A portion of The Villages site is a tributary to Black Diamond Lake. Black Diamond Lake lies partially within the boundary of The Villages site and has been identified as a bog which is sensitive to fluctuations in water levels, changes in nutrient loading, and changes in pH. Typically, under the DOE Manual, the development of a basin tributary to an open body of water would be mitigated using a detention facility combined with a water quality


Lake Sawyer Rd SE
Auburn - Black Diamond Road
Morgan St.
Ginder Creek
Auburn - Black Diamond Road
Horseshoe Lake
1A
1B
1C
Infiltration Pond
2
Rock Creek
Infiltration Pond
5A
5B
Jones Lake
Infiltration Pond
Black Diamond Lake
3A
3B
3C
3D
4
SR 169
SE Green Valley Road
LEGEND
Stormwater Management Zone
Sub-Zone Lines
Sub-Zone Lines (Dependant on final land coverages)
Proposed Pond
Discharge Point
N

facility. Due to the sensitive nature of bogs, the stormwater management approach for Black Diamond Lake will not follow the typical DOE Manual approach.

The existing tributary basin to Black Diamond Lake has been identified for water balance calculations to match the existing stormwater volume conveyed to Black Diamond Lake. Rooftop runoff is proposed to be used to match the existing volume to maintain the hydrology of Black Diamond Lake. Rooftop runoff is specifically being used to ensure clean stormwater is being conveyed to Black Diamond Lake, minimizing the potential for changes in nutrient loading and pH. All non-rooftop generated runoff from within the basin tributary to Black Diamond Lake will be conveyed to a regional stormwater facility where it will be infiltrated into the deep outwash deposits.

ROCK CREEK, RAVENSDALE CREEK, JONES LAKE AND LAKE SAWYER

There are three basins within The Villages site that drain to water bodies, which are tributary to Lake Sawyer. One of these basins drains to Rock Creek, one towards Ravensdale Creek, while the other drains to Jones Lake. All these basins are tributary to Lake Sawyer (Rock Creek flows from Jones Lake to Lake Sawyer and Ravensdale Creek flows directly into Lake Sawyer). All basins will provide flow control per the DOE Manual and must meet the DOE Manual requirement for phosphorous treatment.

WETLAND RECHARGE

There are many wetland complexes throughout The Villages site. To maintain wetland hydrology, the areas to be developed which are tributary to wetlands have been identified. Runoff from rooftops and or yards will be used to match the existing stormwater volume that these areas contribute to each of the wetlands. Excess stormwater in areas originally tributary to a wetland will be routed to a regional stormwater facility which infiltrates into the deep outwash deposits.

OWNERSHIP AND MAINTENANCE

All stormwater facilities, except stormwater vaults serving commercial property, are proposed to be owned and maintained by the City of Black Diamond.

STORMWATER MANAGEMENT ZONES AND STANDARDS

The Villages MPD has been divided into stormwater management zones. Each stormwater management zone has a unique set of specific stormwater requirements that were used to develop the stormwater concept. Developable area, areas of impervious and pervious surface, area of rooftops, the amount of stormwater that can be infiltrated into the shallow outwash (Qvr) and the amount of recharge required for wetlands and Black Diamond Lake, must be determined for ultimate stormwater balance calculations. Water balance calculations will need to be performed based on actual developed conditions to ensure water balance goals are met.

Individual developments are required to meet the overall requirements as well as the stormwater requirements unique to the stormwater zone in which each is located. Each development must provide calculations of the amount of stormwater conveyed to wetland recharge, Black Diamond Lake, the shallow aquifer tributary to Horseshoe Lake, etc. The City of Black Diamond will maintain a running tally and will manage the water balance requirements for each zone to ensure that the water balance goals are met.

REQUIREMENTS APPLICABLE TO ALL STORMWATER ZONES

- Stormwater facilities shall be designed to meet the requirements of the Department of Ecology, 2005 Stormwater Management Manual for Western Washington (DOE Manual).
- Stormwater from rooftops does not require water quality treatment prior to infiltration or discharge unless combined with stormwater from pollution-generating surfaces.
- Stormwater from pervious surfaces that is collected is required to meet the water quality requirements of the Department of Ecology, 2005 Stormwater Management Manual for Western Washington (DOE Manual).
- All treatment options allowed under the 2005 DOE Manual such as ponds, vaults, media filter strips, biodetention and rain gardens are allowed without preference for any one type of facility.

STORMWATER MANAGEMENT ZONE 1

Stormwater Management Zone 1 consists of the north portion of The Villages site. Under existing conditions, all stormwater infiltrates in the outwash soils present within Stormwater Management Zone 1. The main constraint for Stormwater Management Zone 1 is Horseshoe Lake, which lies directly to the west of The Villages site. Horseshoe Lake has a history of flooding problems and may be sensitive to groundwater fluctuations but requires flows to maintain summer use. To address this issue, stormwater infiltration to the shallow outwash soils tributary to Horseshoe Lake is proposed to meet the predeveloped infiltration volume. By matching this volume, impacts to both the low flows and high flows are mitigated. Remaining stormwater will be infiltrated into the deeper outwash soils which bypass Horseshoe Lake through the use of a regional water quality and infiltration facility.

Stormwater Management Zone 1 has been split into three sections. The sections have been divided based on the stormwater management requirements. Stormwater Management Zones 1A and 1B are tributary to Horseshoe Lake while Stormwater Zone 1C is cross gradient from Horseshoe Lake. To ensure that the predeveloped volume of water conveyed to Horseshoe Lake is matched, an accounting of the infiltrated water volume (based on pervious area, rooftop area and impervious area infiltrated) within this zone must be maintained through build out.

STORMWATER CONVEYED TO HORSESHOE LAKE VIA THE SHALLOW OUTWASH SOILS WILL INCLUDE:

- All stormwater in Stormwater Management Zone 1A from areas underlain by outwash soils. The rooftops will be infiltrated directly while the remaining stormwater will be treated to the water quality requirements of the Department of Ecology, 2005 Stormwater Management Manual for Western Washington (DOE Manual) before infiltration.
- All stormwater from Stormwater Management Zone 1A conveyed to the local pond located in the southwest corner of Parcel C.
- All Stormwater from Stormwater Management Zone 1B until the predeveloped average annual infiltrated volume is met. The rooftops will be infiltrated directly while the remaining stormwater will be treated for basic water quality before infiltration.
- Stormwater from rooftops and pervious surfaces used to recharge wetlands.

STORMWATER CONVEYED TO THE DEEPER OUTWASH DEPOSITS (QPOG) WILL INCLUDE:

- All remaining stormwater within Stormwater Management Zone 1.

The stormwater management requirements for each section of Stormwater Management Zone 1 are as follows:

STORMWATER MANAGEMENT ZONE 1A

- All stormwater shall be infiltrated into the shallow aquifer (Qvr) unless underlying soils are till (including till fill area), provided the avg. annual volume to be infiltrated has not yet been met
    - Surfaces requiring basic water quality treatment per the 2005 DOE Manual can be infiltrated in Stormwater Management Zone 1A after basic water quality treatment.
    - Surfaces requiring enhanced water quality treatment per the 2005 DOE Manual can be infiltrated in Stormwater Management Zone 1A after enhanced water quality treatment or can be infiltrated in Stormwater Management Zone 1B after basic water quality treatment.
- All stormwater that cannot be infiltrated based upon the underlying soil, will be routed to the regional stormwater facility located in the southern portion of Stormwater Management Zone 1C.
- All stormwater that cannot be infiltrated based upon the underlying soil and cannot be routed to the regional stormwater facility located in the southern portion of Stormwater Management Zone 1C based on elevation will be routed to the local stormwater facility located in the southwest corner of Parcel C.

STORMWATER MANAGEMENT ZONE 1B

- Stormwater from rooftops and pervious surfaces shall be used to recharge wetlands where required. All remaining stormwater shall be infiltrated to the shallow aquifer (Qvr) provided that the predeveloped average annual volume to be infiltrated has not yet been met.
- Stormwater from pollution generating surfaces (roads, parking lots, driveways etc.) shall be treated for basic water quality and infiltrated, provided the predeveloped average annual volume to be infiltrated has not yet been met. Once the predeveloped average annual volume has been met, all remaining stormwater shall be conveyed to the stormwater facility located in the southern portion of Zone 1C.

STORMWATER MANAGEMENT ZONE 1C

- Stormwater from rooftops and pervious surfaces shall be used to recharge wetlands where required. All other runoff will be conveyed to the regional stormwater facility within this drainage zone (Figure 6-1) unless the runoff is needed to meet the water balance needs to Horseshoe Lake.

STORMWATER MANAGEMENT ZONE 2

Drainage Zone 2 consists of the eastern portion of The Villages site which drains directly to Rock Creek. All stormwater runoff flows to Rock Creek which flows into Lake Sawyer. Lake Sawyer is a phosphorous sensitive lake which is located approximately three quarters of a mile north of the site. In addition to basic water quality treatment requirements per the DOE Manual, phosphorous treatment is required to be provided for all basins that drain towards Lake Sawyer. A detention/water quality pond will be used to manage stormwater for this zone. A large wet pond is proposed to provide basic and phosphorus treatment for this zone.

Runoff from rooftops shall be used to recharge wetlands and maintain wetland hydrology. All other runoff will be conveyed to the detention/water quality pond in this drainage zone. (Figure 6-1)

STORMWATER MANAGEMENT ZONE 3

Stormwater Management Zone 3 consists of the southern portion of The Villages site. A large portion of Stormwater Management Zone 3 is tributary to Black Diamond Lake. A portion along the southwest border of Stormwater Management Zone 3 is underlain with outwash soils, where stormwater runoff infiltrates under existing conditions. The remainder or Stormwater Management Zone 3 is underlain with till soils, with stormwater runoff flowing to wetlands throughout the zone. There are several constraints within Stormwater Management Zone 3. Black Diamond Lake is a bog and as such could be adversely impacted by changes to hydrology. In order to maintain hydrology and mitigate the effects of

development, only runoff from rooftops will be used to recharge Black Diamond Lake. Predeveloped stormwater volumes will be provided to Black Diamond Lake with rooftop runoff. In the existing conditions, stormwater infiltrating in the outwash soils along the south boundary daylights along steep slopes. In order to minimize potential erosion, the predeveloped infiltration volume for this area will be matched. Finally, many of the wetlands within Stormwater Management Zone 3 discharge to steeply sloping areas. To minimize erosion potential, the existing volume conveyed to each wetland will be matched to maintain wetland hydrology. Remaining stormwater will be infiltrated into the deeper outwash soils through the use of a regional water quality and infiltration facility.

Stormwater Management Zone 3 has been split into four sections. The sections have been divided based on the stormwater management requirements. To ensure that the predeveloped volumes of water conveyed to Black Diamond Lake, onsite wetlands, and the outwash soils are matched, an accounting of the water volumes conveyed to each (based on pervious area, rooftop area and impervious area) within this zone must be maintained through build out.

Stormwater conveyed to Black Diamond Lake will include:

- Stormwater runoff from rooftops only.

Stormwater infiltrated in the outwash soils along the south boundary will include:

- All Stormwater from Stormwater Management Zone 3C until the predeveloped average annual infiltrated volume is met. The rooftops will be infiltrated directly while the remaining stormwater will be treated for basic water quality before infiltration.

Stormwater conveyed to deeper outwash deposits (Qpog) will include:

- All other stormwater not needed for shallow aquifer recharge, Black Diamond Lake recharge or wetland recharge.

The stormwater management requirements for each section of Stormwater Management Zone 3 are as follows:

STORMWATER MANAGEMENT ZONE 3A

- Stormwater from rooftops shall be used for wetland recharge and recharge to Black Diamond Lake to match predeveloped volumes.
- Stormwater from backyards may also be used for wetland recharge if needed but CANNOT be used for recharge to Black Diamond Lake.
- All stormwater from pollution generating surfaces shall be conveyed to the large infiltration facility to the west (Figure 6-1).
- Once the wetland recharge and Black Diamond Lake recharge requirements have been met, all other stormwater will be taken to the regional stormwater facility to

the west.

STORMWATER MANAGEMENT ZONE 3B

- Stormwater from rooftops and/or backyard will be used for wetland recharge. All other stormwater not required for wetland recharge will be conveyed to the regional stormwater facility to the west (Figure 6-1).

STORMWATER MANAGEMENT ZONE 3C

- Stormwater from rooftops and pervious surfaces shall be infiltrated to the shallow aquifer (Qvr) provided that the predeveloped average annual volume to be infiltrated has not yet been met.
- Stormwater from pollution generating surfaces (roads, parking lots, driveways etc.) shall be treated for basic water quality and infiltrated, provided the predeveloped average annual volume to be infiltrated has not yet been met. Once the predeveloped average annual volume has been met, all remaining stormwater shall be conveyed to the regional stormwater facility located to the west (Figure 6-1).

STORMWATER MANAGEMENT ZONE 3D

- If Black Diamond Lake requires more recharge volume after the build out of Stormwater Management Zone 3A, runoff from rooftops will be conveyed to Black Diamond Lake to provide the remainder of the volume required.
- Stormwater from rooftops and backyards will be used for wetland recharge.
- All remaining stormwater will be conveyed to the regional stormwater facility located to the west (Figure 6-1).

STORMWATER MANAGEMENT ZONE 4

Stormwater Management Zone 4 consists of the eastern portion of The Villages site which drains directly to Jones Lake. All stormwater runoff flows to Jones Lake which flows into Lake Sawyer via Rock Creek. In addition to basic water quality treatment requirements, phosphorous treatment is required to be provided for all basins that drain towards Lake Sawyer. A detention/water quality pond will be used to manage stormwater. A large wet pond is proposed to provide basic and phosphorus treatment.

All stormwater will be conveyed to the detention/water quality pond in this Stormwater Management Zone.

STORMWATER MANAGEMENT ZONE 5

Stormwater Management Zone 5 consists of Parcel B of The Villages project. The northwest corner of Stormwater Management Zone 5 is located on outwash soils with good infiltration rates. The remainder of Stormwater Management Zone 5 (approximately two-

thirds of the basin) is located on till soils. Stormwater runoff from the northern portion of Stormwater Management Zone 5 drains to the north and northwest overland and through a series of wetlands and a stream to the outwash soils in the northwest corner where it infiltrates. The infiltrated stormwater flows towards Ravensdale Creek. In addition to the till portions of the site, runoff from adjacent offsite parcels to the east also drains to the wetlands and stream on the till portion of the site and infiltrates into the outwash soils in the northwest corner of the site.

The existing volume tributary to each of the wetlands will be matched in developed condition with runoff from rooftops to maintain wetland hydrology. Runoff from the remaining rooftops and other non pollution generating surfaces are proposed to be infiltrated directly. All remaining stormwater runoff will be directed to an infiltration and water quality facility located in the outwash in the northwest corner of Stormwater Management Zone 5. Based on available soils information the existing soils do not meet DOE soil requirements for water quality treatment. Due to this fact, the stormwater from the northern portion of Stormwater Management Zone 5 requires treatment for phosphorous removal and enhanced water quality treatment based on the currently proposed land use. The options available for water quality treatment from pollution generating surfaces prior to infiltration include; large sand filter, amended sand filter, stormwater treatment wetland followed by sand filter, compost amended filter strips or two facility treatment trains.

Stormwater runoff from the southern portion of Stormwater Management Zone 5 drains to the south and southwest where it enters an existing wetland, located along the south and southwest boundaries of the site, and eventually infiltrates. There are several wetlands within this portion of the site. The existing volume conveyed to each of the wetlands will be matched in developed condition with runoff from rooftops to maintain wetland hydrology. The remaining stormwater runoff will be conveyed to two stormwater facilities which will provide detention, phosphorous treatment, and basic water quality treatment.