PORTLAND OFF-ROAD CYCLING MASTER PLAN

Project Advisory Committee Meeting #4

MEETING DATE: THURSDAY, MAY 26, 2016
LOCATION: 1900 SW 4TH AVENUE, 7TH FLOOR
TIME: 4:00 – 6:30 P.M.

MEETING PURPOSE:

Review and discuss the planning approach with regard to system planning for trails
Describe how best practices shape high level system planning and site specific planning and design
Review the current ecological conditions in Portland; present and discuss the findings from the impact assessment and best practices research
Discuss next steps

AGENDA

1.	(Info)	**Welcome and Overview of Agenda** *Adrienne DeDona, JLA Public Involvement*	**10 minutes**
2.	(Info)	**Overview of System Level Planning** *Kristen Lohse, Toole Design*	**20 minutes**
3.	(Info)	**Impact Assessment & Best Practices: Focus on the Environment** *Lori Grant, Bureau of Planning & Sustainability / Tim Brooks, Winterbrook Planning / Nat Lopes, Hilride* ****5 MIN BREAK****	**50 minutes**
4.	(Discussion)	**Committee Discussion** *All*	**40 minutes**
5.	(Info)	**Community Engagement Update** *Adrienne DeDona, JLA Public Involvement / Lori Grant, Bureau of Planning and Sustainability*	**10 minutes**
6.	(Info)	**Public Comment**	**10 minutes**
7.	(Info)	**Meeting Wrap up/Next Steps** *Adrienne DeDona, JLA Public Involvement*	**5 minutes**

PORTLAND OFF-ROAD CYCLING MASTER PLAN

Task 3.2

Assessment of Off-Road Cycling Impacts and Benefits

Draft 5/19/16

Prepared by:

Winterbrook Planning

Hilride Progression Development Group, LLC

Toole Design Group, LLC

Overview

Development of the Portland Off-Road Cycling Master Plan requires understanding the impacts and benefits of off-road cycling. This document presents a survey of studies of these impacts and benefits, related to:

- The environment (e.g. wildlife, vegetation, soil, and water resources, including streams and wetlands)
- The health and safety of park and trail users, including user conflicts and perceived nuisance activity
- The City's economic activity and tourism.

This document summarizes the research findings for each subject area and identifies some limitations and gaps in the research.

This survey will inform the site suitability criteria and site feasibility assessment as well as the development of best management practices and policy recommendations in the Master Plan.

Impacts on the Environment

This section focuses on the environmental impacts of off-road cycling. Where available, research specific to off-road cycling is presented. In some cases, broader research on recreational trails is also presented. This section follows a commonly used framework in the literature that breaks these impacts into four main categories:

- Soil – soil erosion, compaction and water runoff.
- Vegetation – plant health, structure, diversity and composition.
- Wildlife – mortality, habitat disturbance and behavioral stress.
- Water – water quality and alterations to aquatic and riparian habitats.

The review also summarizes the available research on off-road cycling impacts relative to other outdoor recreational activities such as hiking and horseback riding.

The body of published research on the environmental impacts of off-road cycling is limited compared to the research on recreational activities such as hiking (Marion and Wimpey 2007, Davies and Newsome 2009, Pickering and others 2010). Research has focused on soil erosion and related impacts, with a secondary focus on vegetation impacts such as trampling. In one of the more recent literature reviews, Quinn and Chernoff (2010) found no published research specifically on the impacts of off-road cycling on water resources. As noted by several authors, more study on the timing, duration, intensity and spatial distribution of various types of recreational activities would be useful.

Most research on the environmental impacts of off-road cycling focuses on cross-country cycling, with limited published research covering other off-road cycling disciplines such as freeride, downhill, dirt jumps and bike parks. Such research would improve understanding of the environmental effects of the other styles and make comparisons between them possible. However, some facilities such as bike parks could be assumed to have similar impacts to other intensive recreational facilities such as playgrounds or sport courts.

Based on this research, the Portland Off-road Cycling Master Plan proposes a suite of best management practices intend to avoid, minimize, and/or mitigate potential negative impacts and maximize potential benefits. As the body of research is not comprehensive and may evolve over time, the best management practices include monitoring and adaptive management of sites to address unintended impacts. These best management practices can be found in the *Survey of Design, Planning and Management Best Practices for Off-Road Cycling Facilities*, available under separate cover.

Impacts on Soils

KEY FINDINGS

- The available data indicate that off-road cycling, when limited to established trails, has a similar impact on soils to hiking, and a lower impact than horseback riding.
- Frequency of unpermitted off-trail activity by mountain bikes was the greatest cause of adverse soil and vegetation impacts.
- Trail design and landscape factors may have more potential to affect soils than the nature of the trail activity.
- Trails slopes of 12% to 15% are a threshold for significant increases in soil impacts.
- Trails with slopes greater than 12% are strongly correlated with significant increase in impacts to soil and vegetation.
- Cross-slope trails have lower erosion and runoff potential than fall line trails.

According to Marion and Wimpey (2007), the creation and use of trails for recreational activities results in soil disturbance via compaction, muddiness, displacement, and erosion. Soil is generally displaced from the tread center of a trail to the sides, building up soils on the uphill side and compounding drainage problems. Sediment can be carried directly into watercourses, creating impacts to aquatic systems.

The available data indicate that off-road cycling, when limited to established trails, has a similar impact on soils to hiking, and a lower impact than horseback riding. Biking trails that encourage high numbers of users (such as may occur for competitions) may raise the impact levels significantly.

One of the earliest studies of the environmental impacts of off-road cycling was conducted by Wilson and Seney (1994) and focused on soils. The authors studied the potential erosive impacts (water runoff and sediment yield) of four different user types (horses, hikers, mountain bikes and motorcycles) on a national forest trail network in Montana. They found that horses produced significantly larger quantities of sediment compared to hikers, off-road bicycles, and motorcycles. While acknowledging limitations with the study's methodology, the authors concluded that both horses and hikers had a greater erosive potential than wheeled activities such as off-road bicycles and motorcycles, and this impact was most pronounced on wet soils and when going downhill. Other studies cited by the authors found that hikers and horses tend to loosen soil when descending a steep trail because greater forces are applied when decelerating and moving down a steep trail.

Several later studies have assessed soil impacts, including soil erosion, displacement, and compaction (Thurston (1998), Thurston and Reader (2001), Chiu and Kriwoken (2003), Marion and Olive (2006), White and others (2006)). Under the conditions tested, these studies generally found no significant

difference in the effects on soils between off-road cycling and hiking, with White also noting the greater damage that may be caused by horses.

However, several studies have found that the landscape characteristics of a trail can be significant determinants of the extent of soil degradation. For example, trail slope is a key factor influencing the potential impacts to soil and vegetation on recreational trails (Wilson and Seney 1994, Bjorkman 1998, Goeft and Alder 2001, Morlock and others 2006). Marion and Wimpey (2007) found that erosion rates on trails with 0-6 percent and 7-15 percent grades were similar, while erosion on trails with grades greater than 16 percent were significantly higher. Some studies (Marion and Wimpey 2007, Marion and Olive 2006) identified a 15% slope as a threshold for significant increases in soil impacts, while Morlock and others (2006) found that slopes greater than 12% were strongly correlated with higher degradation of soil and vegetation. Cross-slope trails have lower erosion and runoff potential than fall line trails (Marion and Wimpey 2007, Marion and Olive 2006, White and others 2006).

Variables such as soil composition, shade and moisture also influence the potential erosion and compaction impacts from recreational activities, including off-road cycling (Marion and Olive 2006, Morlock and others 2006, Marion and Leung 2001, Bjorkman 1998). These studies suggest that trail design and landscape factors may have more potential to affect soils than the nature of the trail activity.

From their studies in the Southwest U.S., Morlock and others (2006) noted that the frequency of unpermitted off-trail activity by mountain bikes was the greatest cause of adverse soil and vegetation impacts. The authors noted that for the 31 trails studied, there were 106 unpermitted off-trail, or "demand" routes identified. They concluded that the ecological impact of unpermitted off-trail routes was the primary argument for limiting mountain biking access to public lands. In related research in Perth, Australia, Newsome and Davies noted a similar management concern related to unpermitted off-trail mountain bike impacts (Pickering and others 2010).

Impacts on Vegetation

KEY FINDINGS:

- All trail-based recreational activities have the potential to negatively impact vegetation, especially on unestablished trails.
- Most impacts occur with initial trail construction and use, with a diminishing increase in impact associated with increasing use over time.
- Vegetation trampling/removal and soil erosion/compaction are closely linked impacts.
- Removal of vegetation is an inherent consequence in trail construction but that accelerated soil erosion becomes the primary impact once vegetation is lost.

All trail-based recreational activities have the potential to negatively impact vegetation, especially on unestablished or demand trails. Marion and Wimpey (2007) found that the action of crushing or treading upon vegetation, either by foot, hoof, or tire, contributes to a wide range of vegetation impacts, including damage to plant leaves, stems, and roots, reduction in vegetation height, change in the composition of species, and loss of plants and vegetative cover. Most impact occurs with initial or low use, with a diminishing increase in impact associated with increasing levels of traffic.

Vegetation trampling/removal and soil erosion/compaction are closely linked impacts, as soil compaction can restrict plant water and nutrient uptake and limit root penetration. As such, these impacts are often studied together. Several of these joint studies are noted in the preceding section on soils. Wilson and Seney (1994) found that removal of vegetation is an inherent consequence in trail construction but that accelerated soil erosion becomes the primary impact once vegetation is lost.

Research on the specific impacts of off-road cycling on vegetation is limited, and more focused vegetation studies are recommended in the literature. Researchers recommend management practices that focus on impact avoidance, particularly in areas of rare plants and sensitive habitats, and the use of low impact trail construction practices.

Marion and Wimpey (2007) found only one study specifically addressing vegetation effects associated with off-road cycling. This was the Thurston and Reader (2001) study described below. Most of the other research on vegetation addresses impacts from the construction and use of recreational trails in general, without differentiating uses.

Thurston and Reader (2001) constructed an experiment wherein mountain biking and hiking were applied to adjacent, previously undisturbed sample plots in Boyne Valley Provincial Park in Ontario. The authors set up two identical lanes of travel over natural vegetation in a deciduous forest. Hikers and bicyclists were then allowed to travel the lanes, at five different intensity levels. The researchers then measured changes in plant stem density, species richness, and soil exposure before, shortly after, and a year after treatment.

In general, recreational use of the lane of travel resulted in 100% removal of vegetation, and up to 54% increase in exposed soil. The authors' key findings included: "First, impacts on vegetation and soil increased with biking and hiking activity. Second, the impacts of biking and hiking measured here were not significantly different. Third, impacts did not extend beyond 30cm of the trail centerline" (Thurston and Reader, 2001, p.405). One limitation of the study noted by Pickering and others (2010) was that the experiment methodology may only reflect "optimal" riding behavior.

Studies have found that recreational activity contributes appreciably to the loss in vegetation and native biodiversity, but that additional study is needed to assess the scale of the issue and distinguish between different types of recreational use. (Quinn and Chernoff 2010) A recent thesis by Pankiw (2011) studied the effects of varying degrees of long-term recreational trail use on vegetation communities in Ontario, Canada. The author found that trail-influenced environments experienced significant shifts in composition and reductions in species diversity. If conserving species diversity is a major concern,

managers should consider either closing trails or concentrating their use since spatial impacts are large and changes to composition inevitable.

The spread of invasive plant species has been documented for hikers and equestrians through the spread of seed that attaches to shoes, clothing, animal coats and hooves, and particularly dung. Quinn and Chernoff (2010) and Pickering and others (2010) found no published studies specifically addressing the dispersal potential of mountain biking. This is another research gap identified by researchers.

Several researchers have noted that additional studies differentiating between the effects of various types of recreational use on vegetation and native biodiversity would be helpful.

Impacts on Wildlife

KEY FINDINGS:

- Wildlife disturbance can extend much further into natural landscapes than other forms of trail impacts, which tend to be limited to the narrow trail corridor.
- The research on wildlife impacts focuses on a limited set of bird and mammal species, and the results appear to differ depending on the species studied.
- For some species, disturbance from mountain biking trail use on foraging and nesting behavior may be minimal, but fragmentation and alteration of habitat by mountain biking trails may reduce quality of nesting habitat.
- Wildlife impacts can be reduced by ensuring that trails avoid sensitive or critical wildlife habitats, including riparian corridors and wetlands.
- Additional studies of the impacts on wildlife habitat, including special status habitats and rare plant and animal communities are needed. There also is a gap in information on the cumulative impacts of recreational activities in natural areas, both urban and rural.

The research on the impacts of trails on wildlife focuses on a limited set of bird and mammal species. The research results appear to differ depending on the species studied. Additional studies of the impacts on wildlife habitat, including special status habitats such as interior forest or rare plant and animal communities, are needed. There also is a large gap in information on the cumulative impacts of recreational activities in natural areas, both urban and rural.

Marion and Wimpey (2007) note that while most forms of trail impacts tend to be limited to the narrow trail corridor, wildlife disturbance can extend further into natural landscapes. Recreational activities can cause stress and alter wildlife behavior, modify wildlife habitat, and directly injure or kill wildlife through collision.

The research on the off-road cycling impacts on wildlife addresses particular species of birds and large mammals. For example, Taylor and Knight (2003), studied the response of bison, mule deer, and pronghorn antelope to hikers and mountain bikers in Antelope Island State Park, Utah. They compared alert distance, flight distance, and distance moved by each species. The authors did not find a significant difference between hikers and mountain bikers with respect to the reaction of any of the three species to their presence, but noted that bikers cover more ground in a given time period than hikers and thus can potentially disturb more wildlife per unit time. Papouchis and others (2001) studied the behavioral responses of desert bighorn sheep to disturbance by hikers, mountain bikers, and vehicles in Canyonlands National Park. The authors found that sheep fled from hikers in more than half of the human/sheep interactions, but had a significantly lower flight response to vehicles and mountain bikers. The stronger reaction to hikers was attributed to more off-trail hiking and direct approaches to the sheep.

Naylor and others (2009) reached a different conclusion studying female elk in Starkey Experimental Forest and Range in northeast Oregon. During control periods in this study, elk fed and rested with little time spent traveling. The authors found that while travel time increased in response to all recreational disturbance, horseback riding and hiking elicited lower travel times than mountain biking and all-terrain vehicle riding. Both mountain biking and hiking were shown to reduce resting time for elk.

Davis and others (2010) studied the foraging and nesting behavior, territory size, and nest success of Golden-cheeked Warblers, a federally endangered species that breeds exclusively in the mature juniper woodlands of central Texas. The authors conducted the study along trails at two mountain biking sites and two "non-biking" control sites where all recreational activities were restricted. The authors found that nest abandonment was three times greater in biking areas than non-biking areas. They conducted behavioral observations and found that the disturbance from mountain biking trail use on foraging and nesting behavior appeared to be minimal, but fragmentation and alteration of habitat by mountain biking trails may reduce quality of nesting habitat. They concluded that conservation efforts that curtail construction of new mountain biking trails in Golden-cheeked Warbler habitat and reduce the amount of forest open edge habitat created by existing mountain biking trails should promote recovery objectives for the species.

In a study along the Boise River in Idaho, Spahr (1990) assessed the flushing distances of bald eagles when exposed to actual and simulated walkers, joggers, fishermen, bicyclists, and vehicles. The author found that walkers were the most disturbing to eagles, and bicyclists, followed closely by fishermen, were the next most disturbing. Eagles were most likely to flush when recreationists approached slowly or stopped to observe them, and were less alarmed when bicyclists or vehicles passed quickly at constant speeds.

In their discussion of management implications, Marion and Wimpey (2007) suggest that wildlife impacts can be minimized by ensuring that trails avoid sensitive or critical wildlife habitats, including those of rare species, and riparian and wetland areas. Specifically for Portland, the City's Natural Resource Inventory (NRI) notes functional riparian widths (each side of stream) for wildlife including willow flycatcher (123'), frogs and salamanders (100'), deer (200'), smaller mammals (214-297'), birds

(246-656'), beaver (300'), geotropically migratory birds (328'), pileated woodpecker (450'), and general wildlife habitat (100-600').

Impacts on Water Resources

KEY FINDINGS:

- Trails can introduce soils, nutrients, and pathogens, increase water turbidity and sedimentation, alter patterns of surface water drainage, and divert water sources that serve important ecological functions.
- Very little research exists on the specific impacts of off-road cycling on water resources.
- However, several references – both local and national – provide useful guidelines for planning, design and management of trails near these sensitive resource areas.

According to Marion and Wimpey (2007), trail-related impacts to water resources can include the introduction of soils, nutrients, and pathogenic organisms (e.g., Giardia), and altered patterns of surface water drainage. Eroded soil that enters water bodies increase water turbidity and cause sedimentation that can affect aquatic organisms. Salmon, trout and other fish lay their eggs in gravels on the bottom of streams, and sediments can smother those eggs, reducing reproductive success. Sedimentation can also harm invertebrate organisms, which serve as food for fish and other organisms. Trails can intercept and divert water from seeps or springs, which serve important ecological functions.

Current research has not specifically addressed the effects of off-road cycling on water resources, including streams, wetlands and riparian areas. However, other studies on trail-related impacts and design and management strategies can be instructive. Marion and Wimpey (2007) recommend avoiding placing trails in close proximity to water resources, including riparian or wetland areas. Where stream crossings are necessary, the stream should be carefully scouted to determine the most sustainable crossing location, and low impact crossings such as bridges may be warranted. Design and management strategies to limit soil loss from trails are recommended (Marion and Wimpey 2007). Local handbooks, such as Metro's *Green Trails: Guidelines for Environmentally Friendly Trails* (2004), provide useful guidance to planning and design of trails near sensitive water resource areas.

Impacts on Human Health and Safety

KEY FINDINGS

- Participation in outdoor recreation, including off-road cycling, can improve participants' physical and mental health. A positive recreational experience can inspire more use and benefit.
- Bicycling is a top gateway activity that results in an increase in outdoor activity.
- The frequency of injuries in mountain biking is comparable to that in other outdoor sports and the majority of injuries are minor. Riding within one's ability level, using properly maintained bicycles, and wearing helmets and other protective equipment can reduce the risk and severity of injuries.
- Actual and perceived conflicts between different user groups, such as off-road cyclists and hikers, is a potential impact of shared-use trails. Trail education and awareness reduces perceived and actual conflicts between user groups.
- Off-road cycling trails, along with other site improvements, have been successfully used to reduce or eliminate nuisance activities on public properties. Such uses can contribute to real or perceived health and safety threats.

Human Health

There is a large body of research in the United States that links physical activity and active outdoor recreation, such as off-road cycling, to improved physical and mental well-being (Outdoor Foundation, 2011; RTSG Neuroscience Consultants and Specialized Bicycles, 2013). In Multnomah County, 21% of adults are obese, 13% get no leisure-time physical activity, and the average resident reports 4 days of poor mental health in the past month (County Health Rankings, 2016).

Physical activity

Physical activity, at any level, has been shown to improve both physical health and quality of life. Off-road cycling provides all of the three main kinds of physical activity, aerobic, muscle strengthening, and bone strengthening, and each have associated health benefits.

In children and teens, physical activity can improve bone health, cardiovascular and muscular fitness, reduce body fat and the risk of overweight or obesity, and reduce rates of illness and recovery time.

Impacts among adults include lowered risks of early death, heart disease, stroke, high blood pressure, diabetes, depression, and certain types of cancer. For most health outcomes, benefits increase as the amount of physical activity increases through higher intensity, frequency, or duration. All types of people can experience benefits from physical activity, including children and adults, people of various racial and ethnic backgrounds, and people with various disabilities (Office of Disease Prevention and Health Promotion, 2008 and Godbey 2009).

There is limited research specifically on the physical activity-related benefits of off-road cycling. However, the National Interscholastic Cycling Association's (NICA) 2013 Participation Study polled hundreds of student-athletes, parents and coaches, and found that participation in the NICA high school mountain biking program led to improved youth fitness. Nearly all (96%) of survey respondents reported that their health and physical fitness improved because of their participation in the league. The NICA survey also found that student-athletes inspired their parents and siblings to start riding. Similarly, the Outdoor Foundation (2011) found that bicycling is a top "gateway" activity, resulting in participants being more likely to participate in another outdoor activity.

Mental Health

Outdoor recreation, particularly in natural spaces, has also been shown to reduce acute and chronic stress, reduce symptoms of depression, and improve mental health. There is a statistically significant reduction in stress through the use of urban green spaces, regardless of the person's age, sex, or socioeconomic status (Godbey, 2009).

There is limited research that focuses specifically on the impact of off-road cycling on mental health. RTSG Neuroscience Consultants and Specialized Bicycles (2013) studied the effect of bicycling on youth Attention Deficit Hyperactivity Disorder (ADHD) in 54 students at two middle schools in Massachusetts. They found that cycling improves cognition, attention, mood, fitness and decreases impulsivity. Further, the study found that bicycling accelerates cognitive performance in the near term and long-term. Limitations of this study were that it did not evaluate the effect of *additional* exercise in the student's schedules, and also did not account for subjects' ADHD diagnosis percentages. While this study collaborated with Specialized Bicycles and was funded by the Specialized Foundation, its findings corroborate results found in other peer-reviewed studies (Foundation Acta Paediatrica, 2014; Gapin, J. 2010).

Safety

Mountain biking presents a risk of physical injury, though such risk is common to road cycling as well as many other recreational and competitive sports and activities (Gualrapp, et. al., 2001 and Pons-Villanueva, et. al., 2007). The frequency of injuries in mountain biking is comparable to that in other outdoor sports, and the majority of injuries are minor (Gaulrapp et. al., 2001). Various studies have found overall injury rates of approximately 1.0 to 1.5 injuries per 1,000 hours of participation (Gaulrapp

et. al., 2001 and Aitken et. al, 2011). Rates are higher during participation in competitive events, increasing to 3.7 injuries per 1000 hours participation for cross-country events and 4.3 injuries per 1000 hours participation in downhill events (Carmont, 2008). Minor injuries, including soft-tissue abrasions, lacerations and contusions, represent the most common mountain biking injuries (60-75% of all injuries) (Carmont, 2008 and Gaulrapp, et. al. 2001). One in ten injuries is severe enough to require a hospital visit (Gaulrapp et. al., 2001). While more serious injuries, including fractures and injuries to the head and neck, can occur, most injuries are minor and can be minimized through safety precautions.

The main risk factors for injury include excessive speed, loss of control or traction, mechanical problems, inappropriate or improperly adjusted equipment, competitive activity, and riding beyond the physical ability, fitness level, or experience of the rider (Carmont, 2008 and Aleman and Meyers, 2012).

To reduce risk of injury, Carmont (2008) recommends that riders should be well trained, ride within the level of their capability, and learn to dismount safely. Riders should also wear a helmet, padded gloves and shorts, and use a well-maintained bicycle. Such safety precautions have been shown to reduce injury rates and severity. Furthermore, Aleman and Meyers (2012) recommend education about off-road cycling safety, including bike suitability, maintenance, and equipment, proper riding technique, and attentive behavior to reduce the risk of injury.

Data regarding the use of helmets in off-road cycling in the Portland-area is not available. However a survey of college students in the southeastern United States found a higher likelihood of helmet use when riding on mountain bike terrain than on city roads (17% to 12%). (Ross et.al. 2010) Of note is the low overall level of helmet use among the study's population. In Portland, 81% of people wear helmets when riding on City streets (Portland Bureau of Transportation, 2014), suggesting a relatively high likelihood of helmet use among area off-road cyclists.

Trail Experience and Social Interaction

Actual and perceived conflicts between different user groups, such as off-road cyclists and hikers, is a potential impact of shared-use trails, and is noted in research. Conflicts tend to occur when there is limited public land resources and a lack of policies and practices in place for the management of shared-use trails. (Ruff & Mellors; Schuett; Symmonds et al., 2000; Watson et al. as cited in Jellum, 2007) However, land managers may opt to concentrate trails and associated recreational use, in order to reduce overall environmental impacts (Roth, 2000).

Conflicts can be real or perceived and are often rooted in concerns over personal safety, variations in social norms and expectations, and concerns about environmental degradation (Jellum, 2007). Common causes of perceived or actual conflict include:

- *Safety*: There is limited recent research on the frequency of actual hazardous encounters between mountain bikers and other users. However, in a survey of forty land managers in the United States, Chavez et al. (1993) found only one case of reported walker injury. Similarly, Edger (1997) studied 300 accident records for trail users within the Marin Municipal Water District in Marin County, California, and found very few that resulted from biker-walker collisions. However,

Keller (1990) noted a number of problems from the reactions of horses to people riding bicycles (as cited in Cessford, 2003).

People riding bicycles off-road can be perceived as a hazard by hikers when "they are considered to be riding too fast for the conditions (e.g., on crowded, multiple-use trails); not slowing enough when approaching blind corners; or where they surprise people because they move quickly and quietly" (Moore, 1994; Cessford, 1995a as cited in Cessford, 2003). Additionally, some research has found that a pre-existing fear of an unsafe encounter (such as meeting a person on a bicycle travelling at high speeds or on a blind corner) can negatively impact hikers' recreational experience (Chavez, 1996a and Watson et al., 1991 as cited in Jellum, 2007).

- *Differences in physical attributes*: Users on shared-use trails can sometimes experience conflict because of differences in technology, speed, group size or other physical characteristics. In these cases, conflict may be asymmetrical, or one-directional. For example, trail users generally dislike uses that are faster or more mechanized than their own (Federal Highway Administration, 1994).

- *Differences in social values or norms*: According to Cessford (2002), conflicts between users may result from a lack of trail user etiquette that interferes with another user's enjoyment. Such actions could include rudeness or lack of or inappropriate yielding of right-of-way – including failure to announce passing or passing too closely. Cessford (2002) also cites a variety of other potential social conflicts, including "social values such as different lifestyles (i.e., socioeconomic differences), attitudes toward place attachment (i.e., sense of belonging or attachment to a place based on repeat visits or knowledge about a place) (Backlund & Williams, 2003; Clark, 2004), different recreation goals, or motivational differences (i.e., wildlife viewing, socializing, solitude, exercise) (Bjorkman, 1996; Watson et al.)".

- *Concerns over carrying capacity:* Jellum (2007) cites perceptions that a trail's "biophysical (i.e., overuse diminishing environmental integrity) or social (i.e., experience interrupted by lack of solitude or increased noise levels)" carrying capacity has been exceeded as a potential source of conflict.

- *"Last settler syndrome"* – According to the Federal Highway Administration (1994), trail managers often find that traditional trail users often express resentment toward newcomers. This dynamic can be exacerbated in situations where one user group has had long-standing access or has built and/or maintained trails, leading to a sense of ownership over the trails. Mountain bikers, who participate in a recreational activity that has gained popularity relatively recently, may often be considered newcomers in trail situations. However, this dynamic may manifest in situations where mountain biking trails are considered for either opening to other users or closure to mountain biking.

- *Concerns about resource degradation:* According to research cited in Jellum (2007), user concerns about potential environmental degradation can results in conflicts. Such conflicts increase when there is a visual sign of potential damage (i.e. tire tracks, horse tracks, or footprints in mud; trail widening; or damaged vegetation) and can be exacerbated by poor trail design and/or increased use

(Cessford, 2003; White, Waskey, Brodehl, & Foti, 2006 as cited in Jellum. 2007).

- *Familiarity with off-road cycling*: Hikers' experience when encountering people on bicycles may be influenced by the hiker's familiarity and experience in such situations (Chavez et al., 1993; Bannister et al., 1992; Horn, 1994; Woehrstein, 1998, 2001 as cited in Cessford, 2003). Cessford (2002) examined the perceptions that hikers have towards mountain bikers and found that that hikers who actually encountered a mountain biker had more positive opinions toward mountain bikers than those hikers who did not encounter mountain bikers, suggesting conflict was more perceived than actually encountered. However, Chavez et al. (1993) observed that the hiker's with an established negative attitude towards people on bicycles maintained this perception, despite a three-fold increase in mountain bike use over two years and minimal actual safety issues (Cessford, 2003).

  Jellum (2007) studied the use and perceptions of hikers and mountain bikers using the Middle Fork Trail System outside of Seattle, Washington. This research found that a majority (63%) of mountain bikers using the trail also participate in hiking, while only a limited number of hikers (11%) using the trail also participate in mountain biking. As such, hikers may be generally unfamiliar with the mountain biking experience, which may contribute to their experience and perception of shared-use trail environments.

There are multiple ways that trail designers and land managers can address real or perceived safety concerns. Mann and Absher (2008) suggest that communication strategies are more effective than enforcing trail width based regulations for mountain bikers (e.g. bikes only allowed on trails >6') at addressing potential conflicts, as communication can address underlying concerns about safety, social norms, and environmental impacts. Similarly, Cessford (2002) states that infrastructure and programs that increase education and awareness between user groups (i.e. signage, volunteer trail patrols) reduces negative perceptions. Additionally, trail design and maintenance techniques, such as improving sight lines and controlling speed, are widely accepted as best management practices to promote positive social interaction and reduce conflict (Webber, 2007).

Nuisance uses

Across the country, there are examples where new trail and park development has replaced nuisance uses, ranging from littering to criminal activity. Such uses can contribute to real or perceived health and safety threats. Off-road cycling examples in the Pacific Northwest include the City of Seattle's Colonnade Bike Park and Cheasty Greenspace Trails Project, both of which are intended to provide new off-road cycling and recreational experiences and replace the previous nuisance uses with positive, family-friendly outdoor activities. The Seattle Colonnade Bike Park is located below the I-5 freeway in urban Seattle. The site was formerly filled with garbage and noxious weeds and impacted by illegal camping. (Seattle Parks & Recreation) The Cheasty Greenspace project includes the restoration of a 43-acre remnant forest in south Seattle. The Greenspace suffered from invasive plants and garbage dumping and was home to multiple illegal encampments. Work will be done in stages, and include the construction of mountain biking trails, as part of a pilot effort that will assess the impacts of restoration and recreational trails on the environment and community. (Cheasty Greenspace)

Impacts on Economic Activity and Tourism

The League of American Bicyclists rates Portland as a Platinum Level Bike Friendly Community, the highest rating available, for "providing safe accommodation and facilities for bicyclists and encouraging residents to bike for transportation and recreation." Accompanying this rating is a recommendation to "ensure better access to city parks and recreation areas for off-road riding." Infrastructure and programs to provide and promote safe biking coupled with a population mindful of reducing use of fossil fuels and oriented to outdoor activities has resulted in a significant number of bicyclists in Portland, including off-road cyclists. Bicycling contributes to the state and local economy through the manufacture and sales of bicycle-related products and services, and expenditures by people travelling to cycle. The availability of bicycling infrastructure and facilities also serve to draw new residents and businesses.

KEY FINDINGS

A survey of studies of the economic impacts of bicycling at the national, state and local levels provide an estimate of the value of off-road cycling to Oregon and the Portland area, and insights into the economic benefits of increasing access to off-road facilities.

- The growing bicycling industry in Portland contributes nearly $134 million to the local economy. The majority of Portland bicycle-related businesses cite availability of bicycle infrastructure, including off-road cycling facilities, as important to the growth of the industry and their ability to attract top industry talent.
- People traveling to bicycle off-road spend $28 million annually throughout Oregon.
- With an average expenditure of $125 per trip for day off-road cycling trips and $732 per trip for overnight off-road cycling trips, there is opportunity for increases in travel-related revenues in Portland with increased availability of off-road cycling facilities.

Statewide Bicycling Industry

A 2014 report for Travel Oregon (Runyon) estimates the economic value of the entire bicycle industry to the state as creating nearly 2,700 jobs and contributing nearly $84 million in wages and $440 million in sales to the state economy.

Statewide	Number of Businesses	Number of Jobs	Wages and Salaries (millions)	Sales (millions)
Manufacturing	89	609	$24	$117.7
Retail/Service	405	1718	$51.8	$300.3
Other (distribution, tour operation, events)	48	319	$8	$22.7
Total	**542**	**2646**	**$83.8**	**$440**

Approximately 22% of products sold by manufacturers and 77% of retail products and services are sold locally, contributing to their local economy.

The report also found that of the 542 Oregon bicycle-related businesses, a majority are located in the greater Portland Metro area, providing 75% of all bicycle-related manufacturing jobs and nearly 50% of all bicycle-related sales jobs in the state.

The report did not attempt to break out contributions of road cycling versus off-road cycling. Southwick (2013) estimated the total number of cyclists in Oregon as 888,655, and the total number of off-road cyclists in Oregon is estimated as 484,369 (see Statewide and Portland Area Off-Road Cycling Tourism, page 4), indicating a significant portion of the economic benefit of the bicycling industry in Oregon can be attributed to off-road cycling.

Portland Bicycling Industry

The Portland region includes more than 800 companies, both large and small, producing products for the athletic and outdoor industry (Impresa, 2010). It is not the home of any of the major bicycle brands, but has a growing bicycle manufacturing and retail sector. Ibsen (2015) investigates the role of bicycle-related businesses in Portland's economy, including manufacturing, retail sales, distribution and service of bicycles, parts and related gear. Since 2002, the number of bicycle-related businesses in Portland has increased from 22 to 217. The direct effects of these businesses, the result of initial purchases made by customers, is estimated to support 1469 jobs for a combined income of $39.4 million, and total sales of $296.2 million.

Portland sector	Number of Businesses	Number of Jobs	Wages and Salaries (millions)	Sales (millions)
Manufacturing	78	464	$14.7	$129.9
Retail	100	797	$20.3	$36.6
Wholesale/distribution	8	49	$1.6	$108
Service	31	160	$2.8	$30.7
Total	**217**	**1469**	**$39.4**	**$296.2**

Considering the percentages of sales that remain local from the 2014 statewide report (22% of manufacturer's sales, 77% of retail sales), $28.4 million of Portland manufacturer's sales revenues and $51.8 million of retail and service sales revenues remain in Portland.

The ripple effects of Portland's bicycle-related businesses, the measure of how sales affect other industries providing supplies and support and wages paid by those industries, is additive to the direct impacts to estimate the total economic contribution. The total number of jobs generated by the Portland bicycle industry is 2312 for a combined income of $82.8 million. The Total Value Added to the local economy, consisting of wages and salaries, property income and business tax revenue, is $133.7 million.

	Number of Jobs	Wages and Salaries (millions)	Total Value Added to Portland Economy (millions)
Direct effect	1469	$39.4	$64
Ripple effect	842	$45.5	$69.7
Total	**2312**	**$82.8**	**$133.7**

Off-road bicycles, parts, equipment and gear represent some percentage of sales of most Portland bicycle-related businesses. The report did not provide a detailed breakdown across all the businesses participating in the study, but of those that directly contributed sales data, manufacturers estimated off-road equipment to comprise from 15% to 70% of their sales, and retailers estimated 30% to 65% of their sales. Portland also has one retail establishment that sells and services off-road bicycles exclusively.

Bicycle Tourism

National and Statewide Bicycle-Related Tourism

The Outdoor Industry Association (OIA), a trade association for the outdoor recreation industry, produces periodic reports estimating the number of participants in a variety of outdoor activities, and the economic value of the industry at national and state levels. Their *Active Outdoor Recreation Economy Report* of 2006 reported that nationally, 60 million adults bicycle, and one in five over the age of 16 ride off-road. The 2015 *Outdoor Recreation Participation Topline* report shows some decline in

road cycling but significant increases in off-road ridership in the prior three years: mountain biking and BMX riding has increased by 6% and 16.2% respectively, while participation in road riding has dropped by 5%.

National Bicycling Activity	Number of Participants	% Change over 3 Years
Road riding	39,725,000	-5%
Mountain biking	8,044,000	+6%
BMX riding	2,350,000	+16.2%

The Topline report also found that 17.2 million youth (21.2% of all U.S. youth) bicycle, averaging 67.2 cycling outings/cyclist annually, for a total of 1.2 billion cycling outings. 26.8 million adults (12.8% of all adults) bicycle, averaging 54.3 cycling outings/cyclist annually, for a total of 1.5 billion cycling outings.

The total annual, national spending on bicycling in 2011 was over $81 billion: $10.5 billion on gear and accessories, and $70.8 billion on trip-related sales (Southwick, 2012). By OIA estimates, there are 888,655 bicyclists in Oregon. Over 17 million day trips and 1.7 million overnight trips to cycle in Oregon resulted in nearly $6 billion in trip-related sales (Southwick, 2013).

Off-Road Bicycling Tourism at Destinations Areas

Outdoor recreation including off-road cycling is a major economic driver for some communities surrounded by expanses of public lands. In a 2000 study, the trails outside Moab, UT, a major destination for mountain biking, were estimated to generate $1.3 million in economic value to this tiny city of just over 5000 residents (Chakrabarty, 2000). The trail system in Jackson Hole, WY is estimated to generate $18.5 million in expenditures (Kaliszewski, 2011), mostly by tourists, and mountain bicycling activities in Whistler, British Columbia generate $34.4 million (Canadian dollars) in expenditures (Western Canada Mountain Bike Tourism Association, 2007).

Oakridge, Oregon, a former timber-based city 35 miles southeast of Eugene in the Cascade Mountains, has seen significant economic benefit from the development of an extensive trail system nearby. A University of Oregon study (Meltzer, 2014) estimated annual spending by mountain bikers in Oakridge at $2.5 to $5 million, accounting for 5% of the city's total economy.

Statewide and Portland Area Off-Road Cycling Tourism

The economic value of bicycle-related tourism is a function of the number of cyclists, the number and types of travel trips (day or overnight) taken and their regional destinations. A specific study of off-road cycling travel trips to and within the Portland Metro area has not been completed, but a number of studies assessing general bicycling-related travel in Oregon coupled with estimates of the proportion of off-road cyclists provides some insights into the Portland area tourism value.

The Oregon Parks and Recreation Department investigated demand for a range of state park activities. The *Oregon Resident Outdoor Recreation Demand Analysis* found through a 2011 survey that Oregon residents cycled unpaved surfaces on nearly 15 million occasions. 40% of those cycling experiences (6

million) were in Multnomah County. 12.2% of the state population and 11.4% of Multnomah County population participated in these cycling experiences. Based on 2014 population estimates by the US Census Bureau, nearly 500,000 Oregon residents and 90,000 Multnomah County residents are off-road cyclists.

	Population	% Total Population	% Off-Road Cyclists	# Off-Road Cyclists
Oregon	3,970,239	100	12.2	484,369
Multnomah County	776,712	19.6	11.4	88,545

Oregon Non-Motorized Trail Participation and Priorities, also prepared by the Oregon Parks and Recreation Department, reported the number of activity days for unpaved surface cycling in Multnomah County is the highest in the state. Oregon residents cycled on unpaved surfaces in Multnomah County on 2.5 million occasions, nearly five times the rate in Deschutes County, a destination for off-road cycling. The report also notes that in the Portland region, 47% of 'singletrack cyclists' see additional trails in the region as a priority.

Oregon Parks and Recreation estimates for statewide travel expenditures by Oregon residents participating in singletrack cycling, including direct and ripple effect spending, is $82 million annually. Expenditures for day trips include food, fuel, park fees and other services, and total $57 million. Overnight trips, which additionally include hotel or camping expenditures, total $25 million.

Travel Expenditures for Off-Road Cycling Trips in Oregon by Oregon Residents:

	Expenditures for Day Trips (millions)	**Expenditures for Overnight Trips** (millions)	**Total Expenditures** (millions)
Local trips	$45	$3	$48
Non-Local trips	$12	$22	$34
Total	**$57**	**$25**	**$82**

While the report did not break out travel expenditures for singletrack cyclists by region, a rough estimate can be made based on the region's population. Using 2014 US Census estimates, Multnomah County comprises 19.6% of the total Oregon population. Assuming Multnomah County residents travel to cycle off-road in the same proportion as residents statewide, Multnomah County residents spend over $16 million annually on off-road cycling trips.

Travel Expenditures for Off-Road Cycling Trips in Oregon by Multnomah County Residents:

	Expenditures (millions)		
	Day Trips	**Overnight Trips**	**Total**
Statewide	$57	$25	**$82**
Multnomah County *(at 19.6% of statewide figure)*	$11	$4.9	**$16**

Travel Oregon commissioned a study on the value of bicycling-related travel to the state. *The Economic Significance of Bicycle-Related Travel in Oregon* evaluated the amount spent by travelers who participated in bicycle-related activities while traveling to and throughout Oregon in 2012 (Runyon, 2013). Activities included bicycle racing events, organized tours, day road riding, bicycle touring, day mountain bike riding, and other organized bicycling events. "Travel" was defined as 50 miles or more of one-way travel to cycle. The annual expenditures by all bike travelers statewide is estimated to total $400 million, or $1.2 million per day.

Service	Expenditures (millions)
Accommodations and food services	$174.6
Groceries	$53.5
Fuel	$71.5
Event fees	$1.9
Repairs, gear, clothing	$27.9
Overall	**$400 annual, $1.2/day**

These annual expenditures support 4600 jobs, generating $102 million in earnings, $18 million in tax revenue.

In the Portland Metro region, annual expenditures by all bike travelers are estimated to total $89 million.

Day trip	Overnight trip	Total
$33 million	$56 million	$89 million

These local annual expenditures support 700 jobs, generating $18 million in earnings and $4.1 million in tax revenue.

The report estimates a total of 1,151,000 bicycle-related trips in Oregon in 2012: 748,000 day trips and 403,000 overnight trips. Of all Oregon bicycle-related trips in 2012, 80,000 were for day mountain biking: 51,000 for day trips, 29,000 for overnight trips. Day and overnight mountain bike trips were approximately 7% of both all day trips and all overnight trips. The average expenditure per mountain bike party was $125 per day trip, $732 for overnight trips (over 3.4 nights).

Statewide, 2012 annual expenditures for off-road cycling-related travel totaled nearly $28 million: $64 million for day trips and $21.5 million for overnight trips.

Service	Day trip	Overnight trip	Total
Accommodations	-	$5,590,000	$5,590,000
Restaurants/bars	$2,235,000	$4,761,000	$6,996,000
Groceries	$793,000	$3,096,000	$3,889,000
Fuel/parking	$2,168,000	$3,986,000	$6,153,000
Repairs, gear, clothing	$440,000	$1,727,000	$2,167,000
Event fees	$552,000	$716,000	$1,268,000

Recreation and entertainment	$48,000	$462,000	$510,000
Other retail	$152,000	$922,000	$1,074,000
Airfare	-	$289,000	$289,000
Total	**$6,388,000**	**$21,549,000**	**$27,937,000**

In the Portland Metro region in 2012, there were 287,000 bicycle-related trips: 227,000 day trips and 60,000 overnight trips. Assuming the same proportion of statewide trips attributable to mountain biking, there were 20,090 mountain biking trips in the Portland Metro region: 15,890 day trips and 4,200 overnight trips.

Estimates of expenditures for mountain bikes trips in the Portland Metro region are therefore over $5 million: nearly $2 million attributed to day trips and over $3 million for overnight trips.

	Trips	Expenditures
Day Trips	15,890 @ $125/trip	$1,986,250
Overnight Trips	4200 @ $732/trip	$3,074,400
Total	**20,090**	**$5,060,650**

This estimate is considerably lower than the $16 million in total trip expenditures by Multnomah County residents derived from the Oregon Parks and Recreation Department's study. A study to directly analyze the tourism impacts of off-road cycling in Oregon has not been completed.

Bicycle Racing

Organized bicycle races also generate local revenue through event venue rentals and hospitality services for racers travelling to participate in events. *The Economic Significance of Bicycle-Related Travel in Oregon* report included racers travelling for events in their analysis of travel-related expenditures, but did not evaluate the local revenues of event venues. A 2013 study from Linfield College (McNamee, et al, 2013) evaluated local expenditures by off-road cyclists at three race events: two 1-day events in Bend, OR, and one 3-day event in Oakridge, OR. The study found that 65% of the participants came from outside Oregon and included travelers from outside the US. The two Bend events generated a total of $918,200 in sales, and the Oakridge event generated $1.69 million in sales.

The Oregon Bicycle Racing Association (OBRA) offers the largest cyclo-cross racing series in the U.S., with many of the events held in Portland. In addition to smaller weekend and evening races, the Cross-Crusade series draws thousands of competitors and spectators to events around the state. In 2014, three Cross-Crusade events were held in Portland, two in North Portland at the Portland International Raceway (PIR) and one two-day event in Southwest Portland at Alpenrose. 50 to 57 percent of the Cross-Crusade participants were Portland residents, with the remainder travelling from the region, Oregon and from outside the US.

OBRA also sponsors a range of mountain biking events: Short Track Cross Country; Cross Country; Endurance; Downhill; Super-Downhill; and Enduro. Only Short Track Cross County events are held in

Portland in addition to the cyclo-cross events. 62 to 70 percent of the Short Track participants are Portland residents, and nearly one-third travel to Portland to race.

More than half (9143) of the statewide cyclo-cross participants and the majority (2836) of Short Track Cross Country participants in 2014 competed in Portland.

	Number of Events	Participants
Cyclo-cross		
Statewide	51	18,070
Portland area (35 miles)	32	471
Portland	20	9143
Short Track XC		
Statewide	14	3100
Portland	8	2836
Other Off-road events		
Statewide	26	3831
Portland	0	0
Totals	151	37,451

Many of the cyclo-cross events and all of the Short Track Cross Country races in Portland are held at PIR. In 2014, there were 6122 participants in off-road events generating $12,300 in rental revenue for PIR.

	Number of Off-Road Events	Number of Participants	PIR Rental Income for Off-Road Events
Cyclo-cross	6	3286	$8,700
Short Track XC	8	2836	$3,600
Total	**14**	**6122**	**$12,300**

While venue rental income is one small portion of revenue generated by off-road racing events, the number of participants statewide is an indicator of demand for race facilities and the potential for benefits to the local economy through travel expenditures with increased access to race facilities.

Quality of Life Aspects of Access to Bicycling

The natural amenities available to the Portland region provide a draw to new residents, contribute to the satisfaction of current residents, and factor into employers' decisions to locate their businesses. The availability of infrastructure for bicycling in and around Portland, the number of people who bicycle here and Portland's Bike-Friendly rating are regularly cited by real estate services, businesses and lists featuring reasons to move to Portland. It may not be possible to quantify the economic benefit to the region attributable to the accessibility of bicycling facilities, but there is an impact.

In developing *The Economic Impact of the Bicycle Industry in Portland* report, survey questions were posed to bicycle-related business owners in Portland. Participants indicated they see a clear causality between the provision of bicycle infrastructure and Portland's rating and reputation as a bike-friendly

city with the success of the local bicycle industry and the ability to draw top talent. Of those businesses responding, 80% agreed this reputation was part of the reason for establishing their business in Portland. 75% identified access to a good network of off-road, unpaved cycling facilities as important to growth of the local industry, and 95.8% stated Portland does not have that now.

The Jackson Hole study cited earlier surveyed trail users and found overwhelming agreement that availability of well-maintained trail systems are important for making travel decisions and to quality of life at home.

A 2004 study in North Carolina (North Carolina University) found investment in bicycling infrastructure had an array of benefits for residents and tourism. The Northern Outer Banks of North Carolina hosts an extensive system of bicycling facilities, mostly paved, and a high level of bicycling activity. In addition to finding bicycling infrastructure is a strong draw for visitors and the revenues they generate, they found the economic benefit of investment in bicycling facilities outweighs the costs. In their case, the annual economic benefits of cycling is nine times the initial cost of construction of the facilities. Less quantifiable benefits were found to be:

- Enhanced property values near bicycling trails
- Reduced healthcare costs resulting from increased opportunities for healthful exercise
- Increased safety of the transportation system for all

The vital economy of a region is linked directly to quality of life benefits. Recreational opportunities including parks and trails contribute to a high quality of life, which in turn attracts new businesses and residents as well as retaining existing residents.

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PORTLAND OFF-ROAD CYCLING MASTER PLAN

Task 3.3

Survey of Design, Planning and Management

Best Practices for Off-Road Cycling Facilities

DRAFT

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Prepared by:

Hilride Progression Development Group, LLC

Toole Design Group, LLC

Winterbrook Planning

Overview

This report presents existing best practices for planning, designing and managing trails, trail systems, and riding facilities in major urban metro areas. Best practices are methods, techniques, or processes considered standard by an industry because they consistently result in desired outcomes.

The purpose of identifying off-road cycling best practices as part of the Portland Off-Road Cycling Master Plan is to support the plan's goal to lay a foundation for how off-road cycling is planned for in Portland; limit impacts on natural resources; and to promote the health, safety and enjoyment of trail and park users. As such, this Assessment of Off-Road Cycling Impacts examines the impacts, both negative impacts and potential benefits, of off-road cycling in three areas: the environment, health and safety of park and trail users, and the City's economic activity and tourism.

This document includes best practices from published sources, professional experts and case studies. The best practices included in this report are intended to inform the Portland Off-road Cycling Master Plan, and provide a framework for more detailed project- and context-specific best practices for the planning, design and construction of any future off-road cycling trails or facilities.

Summary of Planning, Design and Management Best Practices

Over the past 20 years, mountain biking has become recognized as a mainstream recreational activity. Park and recreation and land management agencies have responded to the popularity of off-road cycling on trail networks and in bike parks by actively managing, planning, and designing off-road facilities to maximize user benefits and minimize negative impacts to the environment in which they are sited.

The best practices listed in this document have become common practice among park and recreation and land management agencies and are based on an approach based in sustainability, from both an environmental as well as a social standpoint. Sustainable trail facilities are being planned and designed to meet multiple objectives: to meet the needs of the users and provide progressive experiences; to protect ecological health; and to be long lasting, low risk, require minimal maintenance and discourage unsanctioned trail building, which may cause degradation.

Ideally, trail planning, design, and management techniques are informed by research. However, the body of research pertaining to the impacts of off-road cycling is not entirely comprehensive. As such, this document forwards best practices intended to avoid or minimize impacts, based on both research and the experience of facility designers, builders and managers. These best practices, informed in part from established trails-specific practices and expert judgement from lessons learned, continue to be refined as riding styles and trends change over time, building techniques progress, and additional facilities are built. In addition, this document supports monitoring and adaptive management trail systems and facilities to ensure that any unintended impacts are accounted for and remediated.

Key Resources

The International Mountain Bicycling Association's books *Trail Solutions: IMBA's Guide to Building Sweet Singletrack* (2004) and *Managing Mountain Biking: IMBA's Guide to Providing Great Riding* (2007) are recognized resources of design and management practices to reduce user conflict, minimize environmental impact, manage risk and provide technically challenging trail experiences for riders of all levels. The U.S. Forest Service *Trail Construction and Management Notebook* (2007) references IMBA's guide as a trail construction resource. Another comprehensive resource for trails planning, design and maintenance is the Metro *Green Trails Guidelines for Environmentally Friendly Trails* (2016); though it has some limitations as it was not written explicitly for trails allowing mountain biking. The Minnesota Department of Natural Resources book *Trail Planning, Design and Development Guidelines* (2007) provides an additional resource.

Section 1: Best Practices for System Planning

The City of Portland strives to provide safe, equitably distributed recreational opportunities for all residents. The system planning process for this project aims to align with the Parks 2020 Vision, Portland Parks & Recreation (PP&R) strategic plan. The following best practices represent the core concepts embodied in Parks 2020, including providing a wide variety of recreation opportunities for all residents, developing a sustainable network of facilities to ensure PP&R's legacy for future generations, and preserving and protecting natural resources to provide "nature in the city".

The best practices for system planning described below should be used to guide the Portland Off-road Cycling Master Plan itself, as well as any future system plans for off-road cycling trails and facilities.

Community Outreach and Engagement

Early and effective community outreach and engagement with the local park users, including the off-road cycling community, park neighbors, and the general public is a critical part of successful off-road cycling trail and facility planning and development. In Portland, such engagement should follow the guidelines of the City's, Portland Parks & Recreation, and/or another appropriate agency's public involvement principles. .

Planners should pay concerted attention to early and meaningful involvement of stakeholders who are likely to be impacted by the plan or development, but may normally have little influence in the decision or outcome. This is particularly true for historically underrepresented communities, including communities of color, immigrant and refugee communities, and community members with disabilities, as well as youth.

Planning and development projects should also include outreach to affected public agencies, relevant City committees, and decision-makers. Coupled with traditional outreach mechanisms to reach the broad general public, such as open houses, community tabling events, online surveys, mailings and social media, partnerships with community based organizations can offer a mechanism to authentically engage those traditionally hard to reach communities and provide a voice to those whom may have a unique perspective to offer in terms of the project plans.

This type of comprehensive community engagement not only provides an opportunity for the project team to understand the community's needs and desires related to off-road cycling, it provides an opportunity for the public to weigh-in and influence the outcomes of the project in order to best meet the needs of the community. Engaging the community from the start with information and meaningful interactions forwards the development of a unified project vision and a high level of community coordination and collaboration.

Case Study

Cully Park: Portland, OR

The Cully neighborhood is one of Portland's most culturally diverse and park-deprived areas,

home to more than 13,000 residents with a mix of commercial and relatively dense residential development. In 2015, this underserved neighborhood opened its first park facility. A unique partnership between the City, Verde, and the Cully Association of Neighbors resulted in a collaborative design and master planning effort between Portland Parks & Recreation, the Cully community, and the Project Advisory Committee. This partnership resulted in direct community participation in the design, fundraising, and development of the park.

Case Study

Community Engagement Planning: Minneapolis, MN

The Minneapolis Park & Recreation Board developed a Community Engagement Plan to codify the protocol for community outreach, noticing and engagement on new park projects. The plan included key goals and protocol for park planners that included:

- Identification of whom to engage on new projects: neighborhood organizations and other representative community groups and individuals.
- Promoting a culture of openness and learning.
- Providing opportunities for diverse ideas and information to influence the development and implementation of park projects.
- Use of available and emerging technology, including social media for outreach and engagement.
- Establishing a Technical and/or Community Advisory Committee.
- Public Noticing protocol including minimum number of days to send notices prior to meetings and minimum geographic area (e.g. citizens living within ¼ mile of the project area will be noticed).

Creating an Integrated System

Distribution of Facilities

Facilities should be distributed to meet citywide needs. Ideally, municipalities can provide local off-road cycling facilities to reduce barriers to use and allow for convenient bicycle or public transit transportation to the facility. Convenient access contributes to greater use of facilities which in turn supports a healthy and active community.

Distribution of Users

Off-road cycling facilities that are overwhelmed by users are an indication of demand and the need for additional facilities. Overuse of facilities, by off-road cyclists or a combination of multiple user groups, can cause environmental damage, increase maintenance needs, and result in safety hazards. Distributing users throughout a system of trails and facilities and/or among individual trails or bike park facilities typically results in greater social and environmental sustainability.

Providing a Range of Experiences

Facilities should provide a range of off-road cycling experiences for all ages and skill levels. This range of experiences can be provided within an overall trail and facility system or, ideally, within each trail

system and facility itself. The range and scale of experiences provided should be based on an understanding of the local user demand, need and regional trends in off-road cycling. These variables are critical to determining how to plan, design and manage facilities appropriately. Performing user surveys and community engagement are essential in understanding local demand, gaps and need. This is true for trail and bike park facilities.

Integrating into a Regional System

An off-road cycling system distributes facilities and users across the City, creating a network of sustainable off-road cycling trails and facilities to meet identified needs at a range of scales, from neighborhood-oriented to serving a broad area. In this way, the City's system integrates into a regional system, where facilities exist within and outside the City to provide a variety of experiences and riding opportunities for a range of cyclists. Ideally, these systems should be linked together through on-street bicycle facilities, off-road cycling trails, and/or public transit.

Site Suitability

Building on the core planning concepts above, the identification and evaluation of candidate sites for off-road cycling should be based on a citywide-scale opportunities and constraints analysis. The suitability analysis should address a range of criteria from ownership, land use, and zoning parameters and restrictions related to the ecological, historical, cultural resource characteristics on each site. The suitability analysis should also attempt to maximize opportunities to address community needs and reach underserved areas. This analysis process will likely require utilizing an interdisciplinary technical team of design and planning professionals, natural resource scientists and operations and maintenance specialists.

Section 2: Best Practices for Facility Planning

The following best practices address facility planning, which encompasses design, operations and programming planning. Once system planning is complete, these best practices guide site specific planning, development and management efforts for individual sites identified in the system plan. These best practices complement public involvement and master planning practices employed by Portland Parks & Recreation and other City agencies.

Site Assessment and Feasibility Studies

Successful park development begins with a thorough site assessment and feasibility study. Feasibility studies provide critical information used to determine a project's goals and objectives, opportunities and constraints, and conceptual design, costs and timeframe for development. This stage is critical to successful design, planning, construction and ongoing operation of the park. A feasibility study should include initial project meetings with park staff, local user groups, and other interested stakeholders. It should also include an assessment of environmental resources, constraints and capacity of the site; evaluation criteria analyses; and analyses of the project's strengths, weaknesses, opportunities and threats (risks) in order to be able to address any agency and community questions and concerns.

Site-specific Community Engagement

As discussed in the System Planning Best Practices section, early and effective community engagement is critical to successful park design and development projects. Site-specific community engagement efforts should follow engagement and equity principles and methods identified by Portland Parks & Recreation and other appropriate public agencies.

Stakeholder Identification

This process identifies the organizations and individuals who could be impacted by a proposed project, and the appropriate level of involvement. This step should also assess the need for specific outreach strategies to engage traditionally under-represented groups and/or balance stakeholder's power and influence. By clarifying who needs to be involved in the next steps of defining the project, this process helps to build the foundation for a successful communication and engagement strategy. Identifying all the stakeholders early in the process is critical to project success.

Park User Surveys

Conducting user surveys enables collection and analysis of usage patterns, demographic profiles, satisfaction indices, barriers to usage, and suggested park enhancements. This type of information informs the prioritization of park facilities and amenities.

Case Study

Trail Use Survey: East Bay Regional Park District, CA

The East Bay Regional Park District conducted a systematic park user survey in the Pleasanton Ridge Regional Park. The goal was to gain an understanding of existing usage patterns and desired park improvements prior to undertaking an update to the park's Land Use Plan. The survey results were combined with feedback received at community meetings and used to guide the development of a new Trails Master Plan. As a result, the Trails Master Plan and Land Use Plan were largely supported by the community and they are currently being actualized.

Public Notification

In addition to complying with City ordinances and Portland Parks & Recreation's public notification requirements, it is good practice to utilize a variety of methods for public notification and offer a variety of opportunities for stakeholders to provide comment. Newsletters (electronic or printed), project websites, flyers, meetings, public hearings, surveys, committees, etc., are effective tools to communicate with the public and gather input.

Case Study

Theodore Wirth Regional Park Master Plan, Minneapolis Park and Recreation Board, MN (2015)

An integral part of the master planning was the community engagement process that, through the work of an appointed Community Advisory Committee (CAC), set the vision for the regional park. The process included design charrettes, online surveys, study teams and focus groups, and the ability to receive comments via mail or email throughout the process. The notification process was robust: news releases were issued on a regular basis regarding planned public meetings, staff action, and plans for park improvements. Copies of these releases were sent to a targeted community and public relations group contact list. Postcards were mailed to residents within three blocks of Wirth Park prior to the first public meeting, charrette, and the public hearing. A project webpage was also created on the MPRB website with regular updates on the public process, dates for events, public impact, a project timeline, news releases, reports, plans, maps, project and park history, and staff contact information.

Design and Development

Conceptual Planning

Initial conceptual planning for a project helps establish the scope, scale, budget and complexity of a project and provides a visual representation of the potential layout of trails, riding facilities, site amenities and infrastructure such as parking and restrooms. A concept plan can be used during the initial community outreach and engagement process to share information with project stakeholders and the community at large by providing a visualization of the project.

Master Planning

Master planning is the process of designing a visualization of the proposed project, which is then used for environmental compliance, permitting, fundraising and the creation of detailed construction documents. The Master Plan integrates input and feedback from the site's owner and stakeholders. Working directly with the local community is essential to a successful Master Planning process. Engaging public agency partners, neighboring landowners, businesses, park advocates, and the local community from initial project envisioning through detailed master planning encourages a unified vision and successful implementation. The development of a detailed project budget, funding plans, construction document requirements, permitting and construction timelines, etc. ensures coordinated, timely and efficient project development. Master planning for staffing, maintenance, operations, events and park programming ensures the long-term sustainable management of the facility.

Environmental Analysis to Inform Design and Permitting

Environmental analysis includes assessment, compliance, and reporting to reduce and/or properly mitigate potential environmental impacts. The design approach should respond to the inventory and assessment of environmental resources developed in the planning stage, using the following prioritized approach:

1) Avoid impacts to significant natural resources;

2) Minimize unavoidable impacts; and

3) Fully mitigate for unavoidable resource impacts.

Sharing early design concepts with natural resource experts and planners can inform the design to better to respond to existing conditions and constraints, as well as help identify potential enhancement and mitigation opportunities. Laying out the existing documented environmental conditions as an integral part of the project baseline can anticipate and avoid design pitfalls and can streamline environmental permitting processes.

Construction Documents

The development of construction documents typically includes a multi-disciplinary design team with a bike park/trail designer; civil, structural and/or geotechnical engineers; landscape architects; and environmental and technical specialists. This design phase includes the production of detailed site plans, construction details, specifications, estimate of probable cost and bidding documents as required to construct the project.

Project Identity Development

Communicating a consistent project identity, vision, goals, milestones, and end user experience is critical to successful community engagement and project planning. Developing a project brand, including selecting an official project name and designing a project logo, provide clear and consistent messaging and enhanced content for websites, press releases, community outreach, marketing and fundraising campaigns, grants, and more.

Case Study

Creating a Public Awareness Campaign: Chattanooga, TN

Chattanooga, TN turned a regional goal of off-road cycling infrastructure development into a public campaign to garner public interest and gain support. They set a goal of developing 100 miles of singletrack mountain bike trails within a 10 mile radius of the City by 2010 and they named the campaign the "Singletrack Initiative". With key organizational partnerships to support the goals and consistent campaign outreach, the project gained community support and was successful.

Project Funding

Many projects require creative financing to secure capital funds; a portion of a project's costs may be raised through philanthropic foundations, grants and/or sponsorship sources. Developing a fundraising strategy for raising funds is important. The strategy should include the general information needed to raise funds, such as an outline of a fundraising proposal (project vision/description, budget, community need, community impact, etc.), identification of funding sources and eligibility requirements. It should also include fundraising protocols, such as sponsorship benefits. A consistent city-wide approach to sponsorship benefits will streamline the fundraising process and ensure a consistent aesthetic throughout the park system. For instance, it should be determined if sponsor logos are allowed on park signage, if parks are allowed to be given a top sponsor's namesake, and what benefits are available/appropriate to offer sponsors (e.g. sponsor logos/links on website).

Construction

Whether the park will be constructed by professional contractors, City or Park staff, volunteers or a combination of these resources, a specialty contractor (professional trail builder or bike park designer) should be on the team to ensure the proper construction of trails and installation of riding features, site amenities and infrastructure elements. This will result in the highest quality and lowest maintenance end product, and will ensure the ideal off-road cycling facility experience.

Facility Management

Operations Plan

An Operations Plan for each facility outlines an overall approach, protocols and actions to ensure the highest quality construction, maintenance, operation and management of the facility. Operations Plans should also ensure that comprehensive integrated risk management practices and protocols are established and maintained by all parties for the lifetime of the facility.

Budgeting for Maintenance

Off-road cycling facilities require regular, ongoing maintenance, and maintenance costs should be identified and factored into planning and operations budgets. Bike parks in particular require regular maintenance; annual maintenance costs can be estimated as approximately 10% of the capital construction cost. Maintenance costs are reduced if a bike park's dirt features are prefabricated with durable materials rather than constructed of dirt.

Maintenance

Ongoing maintenance is most successful when a Maintenance Plan establishes inspection and maintenance activity protocols, schedules, etc. Maintenance activities should be logged and tracked to become the basis for budget and resource planning. Over time, maintenance logs can help in identifying trail segments or riding elements with chronic functional problems or unacceptable environmental impacts, which need to be addressed.

Typical maintenance tasks at bike park facilities include, but are not limited to watering, compacting, shaping and otherwise maintaining the dirt features. Tasks also include routine inspection and maintenance of signage, clearing potentially hazardous debris from fall zones, inspecting and repairing any damaged hardware on wooden structures, inspecting rock and wood features for structural integrity, and maintaining drainage control features and landscaping.

Typical maintenance tasks on trail facilities include, but are not limited to maintaining drainage features and encouraging proper drainage (e.g. deberming and maintaining the outslope, adding drainage features such as rolling grade dips); routine inspection and maintenance of signage; clearing potentially hazardous vegetation or debris along the trail corridor; and identifying problem areas that may need armoring, trail rerouting or reclaiming.

Maintenance can be conducted by staff, volunteers, professional contractors or a hybrid of these options. Ideally, maintenance staff of any kind should have experience or be trained in park maintenance and natural resource protection. Volunteer efforts should be supervised by a qualified and dependable manager.

Risk Management Plan

A Risk Management Plan, addressing both user risk and environmental risk, should be developed for each facility. The plan should establish effective management protocols and demonstrate an intent to manage the facility responsibly. The project owner's risk managers and/or legal department should review and approve the plan. Key elements of a Risk Management Plan for trails and bike park facilities include:

Design, Construction and Maintenance Guidelines.

- Signage Plan: a comprehensive signage program with specific rules and warning language approved.

- Incident and Accident Reporting Plan: a plan that will enable the project owner to record, monitor and respond to hazards in the bike park. Regular evaluation of incidents and accidents should take place to prioritize where maintenance and/or park design changes should take place to improve safety.

- Maintenance Plan: A plan of regular (daily/weekly/monthly/seasonal/annual) maintenance inspections and activities that can be tracked in a log and maintained in the project owner's records. This plan should include who is allowed to and responsible for performing maintenance activities. It should also identify thresholds for unacceptable environmental impacts and methods to address the impacts, such as adaptive management strategies (e.g. seasonal closures).

- Volunteer Activity Plan: Protocols may include requiring all volunteers participating in construction, routine maintenance operations or other special events to sign a liability waiver; requiring all volunteers to wear standard safety equipment (e.g. sturdy closed toed shoes, pants, gloves) during all construction and maintenance operations and activities.

Programming Plan

Land owners or operators of off-road trails and facilities should develop a plan for each facility that outlines the types of programming that are supported at the facility and associated protocols.

Case Study

Trips for Kids, Marin: Golden Gate National Park Conservancy, CA

Trips for Kids takes underserved youth on scenic day-long trail ride adventures in local, state and national parks where they learn bike skills, tips for leading a healthy lifestyle, and gain self-confidence and environmental awareness. The Golden Gate National Park Conservancy supports this effort and allows Trips for Kids to lead regular group rides and youth programming.

Partnerships with Trail Organizations and other Volunteer Groups

Successful partnerships with trail organizations or other volunteer groups can greatly increase a municipalities' capacity to design, construct and manage trails. However, such partnerships should be based on common expectations for performance, communication, and management.

A Memorandum of Understanding (MOU) is a tool for establishing a partnership between two parties to achieve a common goal or action. MOUs are a common tool for recreation facilities with considerable maintenance needs, such as off-road cycling facilities. An MOU is a formal document that establishes a framework of cooperation between the project owner and volunteer groups or organizations who will be assisting in the construction, maintenance and operation of the facility.

Case Study

Banks Vernonia Trail: L.L. "Stub" Stewart State Park, OR

This rails to trails project was spearheaded by a group of trails enthusiasts and eventually established as a state park. Oregon Parks and Recreation Department performs the typical daily maintenance functions of the trail system. Friends of Stub Stewart Park and the Banks Vernonia Trail provide support, under an MOU, to preserve and protect the recreational and educational opportunities of the park and trails, in order to promote use and appreciation of the park's cultural, historical, and natural resources.

Section 3: Best Practices for Protecting and Restoring Ecological Health

The placement and use of any trail by any type of user may have ecological impacts. The goal of this project is to create a sustainable system of off-road trails and facilities. A primary approach to achieving such a system is to site facilities to avoid ecological as well as historical and cultural resources, especially in sensitive areas.

As discussed in the 'Environmental Analysis to Inform Design' best practice, the mitigation hierarchy of avoidance of impacts, minimization of unavoidable impacts, and rehabilitation/restoration of resources through mitigation is the accepted best practice regarding protecting and restoring ecological health.

The best practices identified below are consistent with industry standards established by the U.S. Forest Service and International Mountain Bicycling Association. They also align with the design guidelines and standards for trail construction established in existing Portland Park & Recreation and Bureau of Environmental Services plans and policies.

Note regarding bike parks: The best practices in this section focus primarily on the siting, design and construction of trails, rather than bike parks. Bike parks tend to be sited more commonly in developed park and recreation areas (as opposed to natural areas) and as a result have fewer environmental constraints that demand best management practices. However, bike park design does need to take into account potential soil erosion, water resource requirements, and risk management best practices among others.

Summary of key research findings

The following key findings are based on the Assessment of Off-road Cycling Impacts, available under separate cover. The best practices identified in this section are intended to avoid, minimize, or mitigate these impacts.

Soils

- The available data indicate that off-road cycling, when limited to established trails, has a similar impact on soils to hiking, and a lower impact than horseback riding.
- Frequency of off-trail activity was the greatest cause of adverse soil and vegetation impacts.
- Trail design and landscape factors may have more potential to affect soils than the nature of the trail activity.
- Trails with slopes greater than 12% are strongly correlated with significant increase in impacts to soil and vegetation.
- Cross-slope trails have lower erosion and runoff potential than fall line trails.

Vegetation

- All trail-based recreational activities have the potential to negatively impact vegetation, especially on unestablished trails.
- Most impacts occur with initial trail construction and use, with a diminishing increase in impact associated with increasing levels of traffic.
- Vegetation trampling/removal and soil erosion/compaction are closely linked impacts.
- Removal of vegetation is an inherent consequence in trail construction but that accelerated soil erosion becomes the primary impact once vegetation is lost.

Wildlife

- Wildlife disturbance can extend much further into natural landscapes than other forms of trail impacts, which tend to be limited to the narrow trail corridor.
- People riding bicycles cover more ground in a given time period than hikers and thus can potentially disturb more wildlife per unit time.
- The research on wildlife impacts focuses on a limited set of bird and mammal species, and the results appear to differ depending on the species studied.
- For some bird species, disturbance from mountain biking trail use on foraging and nesting behavior may be minimal, but fragmentation and alteration of habitat by mountain biking trails may reduce quality of nesting habitat.
- Wildlife impacts can be reduced by ensuring that trails avoid sensitive or critical wildlife habitats, including streams and wetlands.
- Additional studies of the impacts on wildlife habitat, including special status habitats and rare plant and animal communities are needed. There also is a gap in information on the cumulative impacts of recreational activities in natural areas, both urban and rural.

Water resources

- Trails can introduce soils, nutrients, and pathogens, increase water turbidity and sedimentation, and alter patterns of surface water drainage and divert water sources that serve important ecological functions.
- Very little research exists on the specific impacts of off-road cycling on water resources.

The following practices reflect both accepted and recommended best practices based on these key findings.

Trail siting to minimize resource and wildlife impacts

Mitigation hierarchy – Avoid, minimize, mitigate ecological impacts

Siting of trails and facilities should follow the mitigation hierarchy of avoiding, minimizing, and then mitigating negative impacts. The application of this hierarchy to a particular area should be based on that area's particular ecological function and value, the uniqueness of the resource within the City and region, and the area's use by resident and migratory species, particularly

Endangered Species Act listed species. In addition, the application of this hierarchy should also consider, and be balanced against, other City goals, including the City's goal to provide accessible recreational opportunities within an urban area.

The mitigation hierarchy should be applied at both the system planning and site planning scale. For example, a citywide assessment should consider potential impacts, and ways to avoid/minimize/mitigate these impacts at a high-level scale. Site planning efforts should take a more detailed and nuanced approach to avoid/minimize/mitigate impacts to individual features or species on a given site.

The City has mapped a variety of natural resources and habitat areas in documents like the Natural Resource Inventory (NRI) and Terrestrial Ecology and Enhancement Strategy (TEES). For example, the TEES defines special habitat areas as including oak woodland; interior forest; riparian, herbaceous and forested wetlands; and prairie. Various agencies and organizations have also identified fish and wildlife species of concern, including Endangered Species Act listed and threatened species, Special Status Species, and other at-risk species lists.

Where appropriate, the City should prioritize trail development on sites with existing disturbance, such as lower value natural areas that have been degraded, over development in higher value resources. Degraded areas offer a potential 'win-win' combination of environmental restoration and new compatible recreational access.

To limit overall environmental impacts in higher value areas or areas the City has prioritized for restoration, additional best practices can limit overall ecological impacts by minimizing overall trail density. These include the use of shared-use trails and 'east coast style' trail systems with tightly packed trails that minimize the overall area impacted.

Maintain habitat connectivity

Trail siting should consider impacts to overall habitat patch size, fragmentation and edge effects. While recreational trails do not have the same fragmentation potential as roads and other types of urban development, such impacts should be considered in site planning. Trails can be routed around particularly sensitive areas or narrowed (e.g. through use of a singletrack trail over a wide trail) to minimize impacts.

Water resources provide important wildlife habitat and habitat connectivity. Trails should avoid crossing streams, wetlands, and floodplain areas. Where no avoidance alternatives exist, the design and construction of trails in these areas should minimize impacts and follow applicable best management practices. For example, design of stream crossings should consider the potential use or retrofit of existing crossings, low impact designs such as bridges or boardwalks, and opportunities to restore disturbed habitat areas as part of the design. Minimize crossing lengths and avoid trails running parallel to streams. Targeted plantings or fencing may be used at crossings to deter trail users from venturing off-trail into sensitive areas.

Buffer sensitive ecological and hydrological systems

Establish habitat buffers to avoid or minimize impacts to sensitive ecological and hydrological systems. The City's Natural Resource Inventory recommends buffers of 100' to 600' depending on the type of resource and presence of wildlife species. Buffers should include migratory pathways that are seasonal in use (e.g. amphibian routes from wetlands to forest habitat). Trails should be located at habitat edges where possible, to minimize disturbance to intact habitats and potentially restore disturbed edge habitat by replacing invasive plants with natives.

Vegetation and clearing guidelines

Trail siting, siting, and construction should minimize tree and vegetation removal, particularly in areas where prevention of runoff and stabilization of the soils on steeper slopes may be an issue. Vegetation can serve useful trail purposes, such as working as "guide material" to define the edges of the trail, thereby preventing unsanctioned cut-through use. The U.S. Forest Services Guidelines acknowledge that vegetation can grow back quickly and become a nuisance or hazard to trail uses, especially trees close to a trail's edge. Tree removal may be prudent for safety reasons. Therefore, vegetation and clearing must consider a balance between natural resource benefits and trail user safety.

Designing trails for natural stormwater management

Trail design can minimize soil erosion and help protect water resources. The River View Natural Area Management Plan includes trail best management practices that are in line with the following BMPs:

Trail Alignment

Trails should be designed to avoid/minimize impacts, such as soil erosion, on streams, wetlands and other water resources through careful consideration and design of the stormwater flow path... First, avoid siting trails on level terrain and/or areas with incompatible soil types. Such precautions can prevent trails that easily become muddy, erosive, and challenging to users. Secondly, design rolling contour trails to enhance natural overland drainage and reduce soils erosion.

Tread Width

To reduce potential soil erosion, trail tread width should be kept to a minimum. This may be accomplished by constructing narrower trails or by narrowing existing trails to reduce the overall trail footprint. However, the width of a trail is a key factor that determines the associated recreational trail experience; as such, trail width, desired recreational experience, and soil suitability should all be considered in concert when siting trails.

Rolling Contour Trails

These trails are designed to follow the elevation contours of hillsides to encourage sheet flow of water across the trail. To minimize erosion, facilitate natural drainage patterns, and provide a fun trail experience, trails should maintain a 5-7% average running grade (i.e., the grade longitudinally along the trail)--or no more than half the grade of the side slope--and include frequent grade reversals. Grade reversals are short dips followed by a slight rise to allow water to drain off before it

can gain volume and speed. Trail tread (or cross slope) should tip downhill or outslope (about 5 percent). Blending the trail's "backslope" (uphill slope) to the hillside's angle of repose will further encourage proper drainage. Developing rolling contour trails (as opposed to fall-line trails that follow the shortest route down a hill) with the following characteristics is a key element in developing environmentally sustainable trails.

Full Bench-Cut Trail Construction

This type of trail involves cutting the trail tread into the uphill side of the slope and providing a solid, long-lasting and stable trail tread by retaining the lower edge without impacting native compact soils and existing well-rooted plants. Cut slopes soils should be broadcast thinly across the downslope over a larger area so as not to suffocate the roots of existing plants.

Slope rules - half rule and 10% grade, maximum grade

Trails should be aligned parallel to terrain contours, and a trail's grade should not exceed half the grade of the hillside or sideslope that the trail traverses (half rule). An average grade of less than 10 percent (ideally 5-7%) should be maintained (10% rule) to minimize erosion of the trail surface, accommodate undulations and to provide the majority of trail users with a rideable trail gradient. Maximum trail grade is typically 15 to 20 percent in relatively low-use areas (lower in high-use areas), however it is site specific and the trail should comply with the half rule and take into consideration variables such as soil type, user density, annual rainfall and difficulty level of the trail. In general, limit maximum grades and sustained grades, and include frequent grade reversals along the trail to provide frequent drainage relief.

Edge Protection

In general, edge protection may reduce sheet flow and increase erosion and trail maintenance. Edge protection should be provided only when conditions warrant it (steep drop off). If used, edge protection should use native vegetation and natural features such as rocks and logs that blend with the natural environment, installed in a manner to facilitate sheet flow.

Trail Hardening

Trails can be hardened to prevent erosion, stabilize steep sections of contour trail, cross low-lying muddy or sandy areas and to toughen high use areas. Each scenario may require a different trail hardening technique and considerations will include if the erosion is caused by users or water, available materials, access to the site and trail use patterns (e.g. high traffic vs. low traffic). The preferred technique is rock armoring, because it is long-lasting, uses natural materials and is aesthetically pleasing. IMBA's *Trail Solutions* describes each method of rock armoring. Commercial products used for trail hardening include chemical binders (i.e. liquid stabilizer), physical binders (e.g. crushed aggregate) and geosynthetics (e.g. geotextile sheets). The Minnesota *Trail Planning, Design and Development Guidelines* has a detailed description of these hardening techniques. Trail hardening in bike park facilities can prevent soil erosion and reduce maintenance requirements, but can also make it harder to update the layout and construction of park features over time.

Trail Construction

There are a number of ways to protect natural, cultural and historic resources during trail construction. Trail construction and maintenance should be performed (or managed) by qualified trail builders. During procurement, use a qualification-based selection process to select contractors based on highest quality work and value of services. Clearly define the boundaries of construction, resource protection areas, staging areas, etc. Manage construction activities to minimize exposure to disturbed earth during the wet season and near sensitive water resources. Work within seasonal work "windows" and build trails outside of breeding seasons for species using the site (i.e. avoid bird nesting season – see TEES Guidelines on Avoiding Impacts on Nesting Birds). Minimize the spread of ecological/invasive species by cleaning tools, boots and equipment prior to entering the project area and make sure imported soil is weed free.

Stewardship

Ongoing stewardship of trails and adjacent natural systems

Periodic monitoring and maintenance of trails are necessary to respond to trail surface and drainage issues before they affect water resources and natural habitats. Ensure environmental protection measures remain effective after trail construction is complete by having a stewardship program in place. As included in the River View Management Plan "implementation of the ecological prescriptions, including monitoring, baseline wildlife studies, long-term research and working with adjacent property owners to remove invasive species" will support the stewardship program. See also sections above on 'Maintenance' and 'Partnerships with Volunteer Organizations'.

Monitoring and Active Management

Monitor for unanticipated/unintended impacts such as excessive erosion, vegetation impacts, wetland/stream impacts, etc. and track maintenance activities including inspection, repair and emergency response with inventory forms. Relocate problem trail sections rather than performing continuous maintenance. Perform conditional closures (e.g. saturated soil conditions) as necessary and consider seasonal closures to protect wildlife (such as during migration or nesting periods). Decommission and restore unsustainable trail corridors.

Environmental Interpretation and Education

Interpretation deepens a user's outdoor experience and appreciation for their surroundings. Interpretive signage is often limited to short walking trails, however providing interpretation on a scale relative to a mountain biking experience provides an opportunity to share a greater amount of information on a larger scale. It also indicates that some trail users may be stopping and reading the interpretation and that riders should ride at an appropriate speed. Interpretation can also encourage 'leave no trace' equivalent practices.

Section 4: Best Practices for User Experience, Health and Safety

Designing facilities for an intended use or target user provides a positive user experience for riders and other users. This is one of the greatest challenges (along with balancing natural resource constraints) and one of the greatest opportunities to meeting the community needs and supporting a healthy and active community.

Summary of key research findings

The following key findings are based on the Assessment of Off-road Cycling Impacts, available under separate cover. The best practices identified in this section are intended to maximize positive benefits and minimize or avoid negative impacts or risks.

- Participation in outdoor recreation, including off-road cycling, can improve participants' physical and mental health. A positive recreational experience can inspire more use and benefit.
- Bicycling is a top gateway activity that results in an increase in outdoor activity.
- The frequency of injuries in mountain biking is comparable to that in other outdoor sports and the majority of injuries are minor. Riding within one's ability level, using properly maintained bicycles, and wearing helmets and other protective equipment can reduce the risk and severity of injuries.
- Actual and perceived conflicts between different user groups, such as off-road cyclists and hikers, is a potential impact of shared-use trails. Trail education and awareness reduces perceived and actual conflicts between user groups.
- Off-road cycling trails, along with other site improvements, have been successfully used to reduce or eliminate nuisance activities on public properties. Such uses can contribute to real or perceived health and safety threats.

The International Mountain Bicycling Association's (IMBA) book *Trail Solutions, IMBA's Guide to Building Sweet Singletrack* is an essential resource of best practices on sustainable multiuse trail design, trail building and trail maintenance. The following are core design concepts that include techniques described in IMBA's guide and best practices utilized by professional trail builders and adopted in communities across the country.

Trail Use Policies: Shared Use, Preferred Use and Single Use

Determining if a trail should be managed as shared use (used by multiple user groups), preferred use (designed and managed for a specific user) or single use (one user type allowed) is site specific. When determining allowable uses, consider three key factors: safety, impacts on natural and cultural

resources, and public input/need. When creating a trail use plan these considerations should be kept in mind:

Shared use trails:

- Can accommodate the needs of most users.
- Are more cost effective to design, build, maintain and manage.
- Can minimize overall trail density and potential ecological impacts
- Typically disperse users across a trail system.
- May lead to conflicts between users of different speeds or modes.

Preferred and Special Use Trails:

- Can respond to community needs while also alleviating conflict/pressures at other facilities.
- Require a well-designed and managed signage plan.
- Do not eliminate conflicts between users of different speeds or modes.

Single use trails:

- Concentrate users to fewer trails.
- Can provide specific experiences desired by off-road cyclists (e.g. flow trails, downhill trails) and alleviate these pressures on the traditional shared use trails.
- Can limit conflicts between users.

Case Study

Competitive Tracks (preferred use/special use areas): Phoenix, AZ

The Maricopa County Regional Park system now includes three competitive trail loops designed for mountain bikers. The trails are designed for training and to accommodate higher speeds and racing events. The three competitive trails are designated as multiuse and are used by cross country runners and endurance equestrians, however they were designed for and are used primarily by mountain bikers. To reduce potential risk of injury the trails are managed as one-directional trails.

McDowell Park offers 3 competitive loops totaling 15 miles, including a beginner level loop, intermediate loop and advance/expert loop. Estrella Mountain Regional Park includes 3 competitive loops totaling nearly 16 miles with a short “Junior Loop”, “Long Loop” and “Technical (advanced) Loop”. The Sonoran Loop Competitive Track is a stacked loop trail system with 9.3 miles of trail and a 1 mile technical segment designated for experts only.

The three competitive tracks are geographically distributed in the County, so there is a track in close relative proximity to each community.

Effective signage is an important risk management practice at these tracks. Each park map includes this caution: This TRACK is for high speeds, challenging one’s skills and racing. Use TRAILS elsewhere in the park for leisurely traveling. The maps also stipulate that slower users shall yield to faster users.

Case Study

Concrete Bike Park (single use): Fresno, CA

The City of Fresno's Parks, After-School, Recreation and Community Services Department developed a 30,000 square foot concrete bike park named Mosqueda Bike Park; it is the largest concrete BMX-only bike park in the country. The park was designed and developed to meet the needs of the BMX community who wanted a concrete bike park experience designed specifically for the BMX user group. The goal was also to disperse BMX use from the other skatepark in the City.

User Experience

Progression

Skills progression is one of the most important aspects in designing dynamic, long-term off-road cycling facilities (trails and bike parks). Progression-based facilities provide opportunities for developing new skills and techniques and minimize risk by providing riders opportunities to incrementally improve their skills through repetition. Progression-based facilities can be designed to provide compelling experiences for all levels of users from novice to advanced. They should be designed to promote a community of learning and advancement while providing safe, fun and exciting experiences.

Stacked Loop Trail System

In a stacked loop trail system, trails are 'nested' or 'stacked' within each other. In such a system, there may be a short loop near the trailhead, a moderate loop extending partway into the site, and a long loop extending even further. Stacked trail systems provide a looped trail options that accommodate many skill levels and provide a variety of riding experiences. Shorter loops, beginner level trails, and denser sections of trail should be sited near developed areas or trailheads to enhance accessibility and separation of user skill levels for safety.

Designing for Riding Experience

Each rider's preferred off-road cycling experience is unique, however there are a number of experiences that are almost universally desired in a trail setting. A flow trail is one of these; it is designed for maximum flow and minimal pedaling and braking using grade, banked berm turns and consistent rolling terrain. Another is providing diverse trail experiences and an opportunity for challenging lines (either mandatory or optional). Intermediate to advanced off-road cyclists generally desire longer distance routes, and narrow or singletrack trails with flowing banked climbing turns (as opposed to switchbacks). Similarly, there are riding features and erosion control features that are not compatible with off-road cycling, such as stairs and water bars.

Bike park facilities offer a great opportunity to design for desired riding experience, because they are typically single-use facilities, are purpose-built and can be updated to reflect changing community needs.

Stakeholder engagement is key to understanding the local trends and desires in a local and/or regional community. Designing for riding experience is easiest when designing new trails or bike facilities.

Natural and Prefabricated riding features

Many off-road cycling facilities now incorporate prefabricated skills features as an alternative to site-built features or features constructed of dirt. While the upfront cost is higher for prefabricated features, the benefits include increased lifespan of the feature, reduced maintenance requirements and reduced liability. The drawback is that they are more permanent in nature. A facility that is intended to be redesigned and updated periodically to accommodate user's changing needs may be better suited using dirt and/or locally sourced materials built onsite.

Recreational and/or Competition Use

If races or competitions are allowed in a park, develop a protocol for frequency of events allowed, which provides an equilibrium between these uses that is appropriate for the park users and the local community. For example, competitions could be limited by size of participants and/or frequency of events allowed per month or per year.

Shared Trails

Shared use trails require careful planning and design to ensure they provide a quality, enjoyable recreation experience for all intended users. This requires understanding the existing and/or intended user groups, usage patterns and user desires. Key factors of design and management include:

Sight Lines

Sight lines improve safety, especially on bi-directional trails, shared use trails and before approaching trail junctions. The wider the trail (and the faster the potential user speed) the longer the sight lines should be. The more twisty the trail (and the slower the potential user speed), the shorter the sight lines can be. On bi-directional trails, blind corners should be designed to rise at both approaches so users meet at slower speeds.

Directionality

On high use multiuse trails that are experiencing user conflict that cannot be managed through trail design or maintenance, consider instituting an opposite direction of travel for different user groups (i.e. hikers and bikers will travel in opposite directions along the loop and pass each other head-on) to maximize sight lines and visual interaction (hikers are less likely to be startled).

Passing/Regrouping Areas

Passing areas are wider sections of trail that allow riders to safely pass other riders or trail users. Passing and regrouping areas should be designed throughout a trail system to prevent users from straying off the trail and impacting the surrounding habitat. Installing a skills feature at regrouping areas encourages groups of riders to regroup at that point rather than elsewhere along the trail.

Signage & Wayfinding

Clear and consistent signage is at the core of successful off-road cycling facility design and management. Signage should enhance the user experience and minimize risk by informing users of trail conditions including park rules, trail difficulty, enhanced terrain and technical features, trail etiquette, riding technique, appropriate safety equipment and emergency medical services. In the context of a bike park or skills trails, providing recreational interpretation, which shares riding techniques promotes progression and skills improvement and will improve user experiences and safety. Well-thought out signage and wayfinding materials can also improve accessibility for those using handcycles or other adaptive features.

Activating Negative Use Areas

Negative use areas are undeveloped areas that are predominantly used for nuisance and negative activities such as dumping or drug activity. Activating these areas with recreational opportunities can displace the negative use with positive use.

Case Study

Seattle, WA

The City of Seattle, WA has supported two projects that provide accessible off-road cycling and recreational experiences to the community and displace negative activities. The 7.5-acre Colonnade Bike Park was developed under Interstate 5 and resulted in activating the area with positive, family-friendly outdoor activities. The Cheasty Greenspace project includes the restoration of a 43-acre remnant forest in south Seattle. The Greenspace suffered from invasive plants and garbage dumping and was home to multiple illegal encampments. Work will be done in stages, and include the construction of mountain biking trails, as part of a pilot effort that will assess the impacts of restoration and recreational trails on the environment and community. (Cheasty Greenspace)

Risk Management

A number of techniques can be used to reduce rider risk, maintain a safe facility and minimize losses from lawsuits. These can include sequential skill progression, particularly in bike parks, where riders can find features appropriate to their skill level. Signage that communicates the technical difficulty of trails and features; filters that require riders to overcome an obstacle (such as a rock garden) at the beginning of a trail segment; and optional lines that allow riders to opt-out of challenging natural or manmade obstacles, can all help ensure riders choose trails appropriate to their ability. Adequate sight lines, which allow riders to see what is ahead, and fall zones can reduce the likelihood and severity of falls. Finally, performing regular maintenance on all off-road cycling facilities in compliance with maintenance plan protocols can ensure trails and facilities remain in a safe, rideable condition appropriate to its technical difficulty.

Monitoring & Adaptive Management

Monitoring and adaptive management can reduce safety risks and improve overall user experience. Monitoring including logging incidents and accidents, assessing overall patterns, and identifying high

priority risks. This is followed by inspecting recurring problem areas and making site-specific trail or bike facility modifications. These modifications could include increasing sight lines, adding wayfinding signage, improving the flow of a turn, etc.

Section 5: References

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PORTLAND OFF-ROAD CYCLING MASTER PLAN

Task 3.3

Survey of Design, Planning and Management Best Practices for Off-Road Cycling Facilities

Appendix A

REVISED DRAFT 5/19/2016

Prepared by:

Hilride Progression Development Group, LLC

Toole Design Group, LLC

Winterbrook Planning

Appendix A: Off-Road Cycling Best Practices as Addressed in Existing Portland-area Plans

City of Portland Plans

Recreational Trails Strategy: A 20-Year Vision (2006)

This plan sets a long-term vision for completing the City of Portland Regional Recreational Trail System (Portland Parks & Recreation (PP&R)). The plan outlines three types of trails: regional trails that "connect communities and significant natural features," community connectors, and local access trails. The plan does not specify which trails currently serve off-road cycling, and the plan generally focuses on shared use paths or on-road cycling trails.

Trail Design Guidelines for Portland's Park System (2009)

The PP&R Trail Design Guidelines (2009) sets trail design standards to guide city staff in design and maintenance of trails within the City's parks system. The Parks 2020 Vision plan had previously identified the need for trail standards, particularly for different trail types and to implement consistent regional signage. As noted in the plan, the main goals for trail design are: safety, connectivity, context, and diversity of users (accessible trails use the United States Forest Service or USFS standards). The design guidelines note the need for some trails that separate different user groups. The design guidelines include a matrix with several different typologies, trail types, design features, and users. Three trail types are most relevant to off-road cycling (schematics included in the plan document):

- Trail Type G: Mountain Biking- One way or two way single track, 18'' wide for one-way single track, up to 4' wide. Notes design parameters, users, and materials (compacted soil/gravel to prevent erosion).
- Trail Type H: Cyclo Cross--The guidelines note that Gateway Green may be developed for a practice course, generally native soil/turf, 6'-12' typical width (20'-40' starting area)
- Trail Type J: Hiking and Mountain Biking—this trail type is described as more suitable for beginning/less experienced mountain bikers. Native soil/rock is the most common material. 4'-10' trail width is recommended with passing areas.

River View Natural Management Plan (2015)

The River View Natural Area is a 146-acre property (riparian forest) in SW Portland, located on the west side of Willamette River within the Westside Wildlife Corridor. A major goal of the plan is to provide

recreational access that is compatible with natural resources protection. The RVNMP takes an 'Ecological Management Program' approach, which sets 'ecological prescriptions' in order to prioritize site restoration efforts. The vision for the site includes "safe and sustainable trails" and recommends that trails be located within 200 feet from the edge of the property boundary. "On-trail recreation" is described as an appropriate use within the site. The Plan recommends that trails create loops, to decommission "demand trails" and to close trails seasonally to protect water quality. The development concept for the site includes a trail system guided by Best Management Practices, as well as recommended half street improvements. Half-street improvements (SW Palatine Hill Road) include shared lane markings. The planned trail system is envisioned as "mainly soft surface" trails meeting the 2009 Trail Design Guidelines. The report describes that trail design is guided by several BMPs, designed to create trails that are sustainable from both a maintenance and environmental perspective. Key trail BMPs listed in the report include low-impact stream crossings, side hill trails, trail alignment, grade, maintenance, minimizing riparian corridor/wetlands impacts, trail safety, and signage. Refer to the report for more detail.

The plan notes that existing trails are not to City standards, include "demand trails" and logging roads, and states that "demand trails" have impacted vegetation and stream health.

According to the plan, biking 'of any kind' is 'interim prohibited' on the site, pending the completion of the City Off-Road Cycling Master Plan.

Gateway Green Vision Plan

Gateway Green is a 35-acre parcel of vacant land at the intersection of I-84 and I-205, acquired by the City of Portland in 2014 from the Oregon Department of Transportation. The vision for the property is to develop it for conservation and off-road cycling. A site analysis was conducted in 2006 as a Portland State University master's in urban planning capstone project. This report noted that the property is accessible by TriMet light rail and the I-205 shared use path, and currently is a "main line" for stormwater runoff from I-205. The site analysis included a freeriding facility as a potential site element.

The 2008 Gateway Green Vision Plan notes existing makeshift bicycle jumps and trails, and also transient activity. The site is adjacent to Rocky Butte, although separated by I-205 currently. Bicycling is identified as key activity for the site, specifically focusing on mountain biking, cyclo-cross, and free riding. This plan envisions the site developed for recreation, open space, and alternative energy innovation. Key goals include economic development, open space, recreation, and connectivity; environmental quality, and placemaking. The Gateway Green vision would add park space in East Portland, which would have both air quality and equity benefits. An initial (Phase 1) rendering was completed in 2014, which includes technical riding tracks, a multi-use path, single track trails, and a nature play area.

Forest Park Natural Resources Management Plan (1995)

The Forest Park Natural Resources Management Plan (NRMP) was developed in order to protect park resources and manage its uses. The Plan states that increasing levels of recreation have contributed to conflicts between user groups and with local residents, and that future management of the park should balance impacts to natural resources with the need to accommodate recreational uses.

Cycling use on Forest Park trails is noted in South Unit and Central Unit. The Plan notes that off-road cyclists are allowed on fire lanes, one-way traffic on Holman Lane, and trail loops. The plan states that construction of a new loop is planned in the Central Unit (between Fire Lane 5 and Leif Erikson). The Plan notes that there is a grand total of 25.86 miles of trails open to bikes, which would increase to 29.23 miles "when the projects identified in the NRMP are completed".

Plan recommendations include:

- Divide the park into three management units (based on levels of usage). All three units currently allow bikes, and will continue to do so. The NRMP envisioned additional bike trails in the South and Central units (between Firelane 1 and NW Germantown Road). The plan includes language on restricting use to that which is appropriate for management unit and season.
- Connect park trails to regional trails, and to plan future trail extensions with "least possible impact" to sensitive areas
- Encourage bicycle, pedestrian, and transit access to the park
- Development of other recreation sites to relieve pressure on Forest Park
- Estimation of recreational 'carrying capacity.' To that end, the Plan recommends completing a survey of current recreational use.

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Cycling use on Forest Park trails is noted in South Unit and Central Unit. The plan states that off-road cyclists are allowed on many fire lanes, one-way traffic on Holman Lane, and trail loops. Specifically, the plan states that cyclists are allowed (currently, circa 1995) on Holman Rd., Leif Erikson Rd., and Upper Fire Lane 1 in the South Management Unit, and Leif Erikson, Saltzman, Springville, and Fire Lane 3 in the Central Management Unit (p. 76). Proposed trails included the South Trailhead at US30/Leif Erikson, North Trailhead at Yeon to Lower Fire Lane 1 (South Unit); and Fire Lane 5 with extension (Central Unit). The plan states that construction of a new loop is planned in the Central Unit (between Firelane 5 and Leif Erikson Drive). The Plan notes that there is a total of 25.86 miles of trails open to bikes, which would increase to 29.23 miles "when the projects identified in the NRMP are completed".

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- Estimation of recreational 'carrying capacity.' To that end, the Plan recommends completing a survey of current recreational use.

Forest Park Single Track Advisory Committee (2010) Single Track Advisory Committee 2010

The Forest Park Single Track Advisory Committee formed to explore options to enhance single track opportunities in Forest Park (without major changes to the NRMP). Bikes currently have limited access to single track trails in the park, defining single track as "narrow trail that has a natural surface and tends to wind around obstacles."

Within the Committee's work, only changes to the South and Central Units were considered (per PP&R staff direction). The majority of the committee supported improvements to fire lanes, construction of single track trail in the South Unit, and improvements/construction of single track on utility corridors (loops and access from Highway 30 to Leif Erikson Rd). Management actions recommended by the committee included completing a comprehensive wildlife and vegetation study, completing a recreational user survey, funding for operations, maintenance, and enforcement.

According to the report, the committee did not reach consensus on the trail actions because a minority wanted management actions completed before trail actions would be considered to determine carrying capacity of the park. One challenge was unknown type of land use review required by the NRMP. The report notes that over 90 percent of mountain bikers wanted trail sharing and new mountain bike singletrack trails. Steep incline was noted as a concern in order for trails to be accessible to families and beginning cyclists as well as the need for contour trails. New trails were noted as an opportunity to enhance vegetation.

In response to the recommendations presented by the Single Track Advisory Committee Report, Commissioner Fish wrote a letter which put forth the 'next series of longer term commitments' related to Forest Park. Recommended actions included starting a vegetation monitoring program, conducting

outreach and education related to trail etiquette and safety, and seeking funding for wildlife study. The Commissioner concluded that Forest Park is not ready for expanded off-road bicycling access, and recommended improving one or two fire lanes. The Portland Fire Bureau voiced concerns about this in regards to safety. Fire lane improvements were later retracted as a viable option when the Fire Bureau determined that such improvements would interfere with emergency access. According to the letter, the City will proceed with further recommendations based on the outcome of these studies. The Commissioner also recommended to increase off-road cycling opportunities outside of Forest Park (Gateway Green, temporary skills parks, and Powell Butte).

Forest Park Desired Future Condition and Ecological Prescriptions (2011)

The Forest Park Desired Future Condition relates to the desired condition for the plant community structure and ecological conditions for the next 25 years in order to set goals for restoration. The Desired Future Condition is stated as being complementary to the FP NRMP. Ecological goals for Forest Park include conditions related to air, water quality, the structural complexity of the forest, increasing biodiversity, and reduction of fire risk. The Ecological Prescriptions (EP) document outlines projects, action items, and timeline for each ecological goal. The EP document recommends developing "wildlife friendly design standards" as new infrastructure is built (including site selection, design, and construction). Additionally, the document suggests developing BMPs for roadside maintenance that minimize the spread of invasive species and minimizes wildlife disturbance.

Forest Park 2012 Recreation Survey (PPPP&R and Portland State University)

This survey was conducted in order to better understand current recreational activities in the park and in order to assist in forecasting future demand/"carrying capacity." Increasing cycling trails was included as the action most often cited to "improve people's experience" at Forest Park, and many comments related to improving mountain bike access or single track opportunities. The survey report notes that there were strong proponents and opponents of bicycle and dog access to the park. 9.3 percent identified cycling as their primary activity at the park. 7.1 percent of respondents bicycled to the park, while 48.7 percent stated that their primary motivation to visit the park was "exercise and fitness." The report also noted that the survey respondents were "overwhelmingly" white, male, adults, with higher than average household income and education.

Forest Park Wildlife Report (2012)

Conducting a wildlife study was one of the recommendations of the Forest Park Single Track Advisory Committee Report. The Forest Park Wildlife Report identified gaps in wildlife knowledge, threats to wildlife, and next steps. Threats to wildlife noted in the report included climate change, non-native invasive plants, insects, and other wildlife; utility corridor management, rogue trails/nocturnal

recreation (nighttime cycling noted), air pollution, domestic cats and fire management. The report also notes that connections between wildlife and recreational users is currently poorly understood, and states that recreational user groups tend to place blame on other groups. According to the report, although many wildlife species in Forest Park are nocturnal no quantitative data exists to document the claim of negative impacts to wildlife related to nocturnal cycling, although many wildlife species in Forest Park are nocturnal.

Forest Park Project Objective Screening Tool (2014)

In 2014, the City of Portland PP&R published a screening tool to be used for preliminary analysis of construction and capital projects with a total cost of at least $10,000 (not used for minor trail reroutes less than ¼ mile in length). This screening tool included three categories of evaluation criteria: Ecology (60 points), Wildfire Risk Reduction (5 points), and Recreation (35 points). The recreation criteria states that recreation will be managed in levels of intensity, with the highest levels of activity in the NRMP's South Unit and the lowest levels in the North. The report cites earlier recommendations to "construct and maintain a sustainable, safe trail system" and recommends expanding "appropriate" facilities within limits of resource protection. Sub-criteria under recreation include NRMP and Environmental Review, Park Stewardship, User Experience, and Future Recreation Demands. Under Future Recreation Demands, "off street bicycle trails" is listed as the third priority after soft surface walking trails and nature and wildlife observation areas.

Metro Plans

Off-road Cycling Opportunity Inventory (2016)

This report details current off-road cycling trail types and riding styles, opportunities, gaps, and site selection criteria. The trail types mentioned in the report include Natural Surface Multi-Use Trail, Fire Service/Maintenance Road, Dual Track, Single Track, and Structure and Jumps. The report also mentions several categories of riding styles (Cross Country, All Mountain, Free Ride, Downhill, Slalom, Pump Track, Dirt Jumping).

Brief design information is included below:

- **Natural Surface Multi-Use Trail**: Often constructed using decomposed granite or crushed aggregate. This trail type is intended for all ages and abilities (bicycles, pedestrians, sometimes equestrians). The running slope is not to exceed 8 percent, with a recommended maximum slope of 5 percent. Multi-use trails are two-way facilities with a recommended width ranging from 48-120 inches.

- **Fire Service/Maintenance Road**: Constructed using crushed gravel. Slope and width requirements may vary depending on agency. This is a shared use facility designed to accommodate fire trucks and maintenance vehicles.
- **Dual Track**: Common in competitive racing courses and usually constructed of compacted earth. Recommended trail widths range from 36-60 inches. Single use is recommended for this trail type, which also accommodates one-way travel.
- **Single Track**: Appropriate riding styles include cross-country, all-mountain, downhill, and slalom. This trail type is typically constructed with compacted earth, and recommended trail widths range from 6-36 inches. Single use is recommended for this trail type, which also accommodates one-way travel.
- **Structure and Jumps:** This trail type is appropriate for use as a freeride course, or as part of a pump track or dirt jumping riding style facility. This trail type should be designated as single use, with recommended widths ranging from 6-36 inches.

Current off-road cycling opportunities in the Metro region include three natural areas that officially accommodate off-road cycling (Forest Park, Powell Butte, and Sandy River Delta Park) and two off-road cycling skills parks (Eichler Park, Beaverton, and Ventura Park, Portland). Based on Metro's analysis of off-road cycling gaps, there are currently no off-road cycling opportunities in the southern half of the region, and over half a million residents are not served. The report notes that multi-use trails are the most common trail type, while single/dual track and skills park/pump track are the least common trail facility types.

The Metro report also developed a set of evaluation criteria intended for use in developing suitability maps to assess parcel-level suitability for future off-road cycling trails. Evaluation categories included physical site characteristics, property ownership, and income distribution (equity). The general process for site suitability includes GIS raster analysis using the site selection criteria, and overlaying suitability maps in order to develop a map of sites for further investigation. After this initial step, recommended investigation steps include reviews of soil and vegetation conditions, Crime Prevention Through Environmental Design, field terrain, and site access.

North Tualatin Mountains Natural Area Project (ongoing, 2015 documents)

The North Tualatin Mountains Natural Area is a property owned by Metro and located north of Forest Park. A planning process is currently underway to determine future uses of the site. Public involvement expressed strong interest in "ride to ride" opportunities as well as in favor of increased off-road cycling opportunities. However, some participants did not feel that off-road cycling was appropriate on the property. Generally, the public expressed a preference for trails that separate different user groups (or

provide a mix of shared and separated trails), and preferred loop trails. Public involvement also recommended using best practices to accommodate drainage during trail design and to utilize old road networks where possible.

Based on draft recommendations presented in late 2015, Metro recommended developing two of four sites (1300 acres total) for public access (hiking and off-road cycling trails). Within these two sites, about five miles was recommended for off-road cycling only, four miles of shared use trails, while habitat restoration efforts are proposed to continue on the remainder of the property.

Green Trails: Guidelines for Environmentally Friendly Trails

This comprehensive manual addresses general principles for trail planning and design, minimizing impacts, and information about site-scale design and maintenance. In addition, being a Portland-specific document, it will serve as one of the most valuable resources on which to draw for planning, design, and management best practices.

Summary

Current best practices for planning, design, and management of off-road cycling facilities in the Portland area are included in the City of Portland Trail Design Guidelines (2009) and the Metro Off-Road Cycling Opportunity Inventory (2016). Other current practices include a series of planning documents and studies related to the management of Forest Park, as well as ongoing efforts to develop off-road cycling facilities or other trails on city/regional properties (i.e., Gateway Green, River View Natural Area, North Tualatin Mountains Natural Area). Generally, many park planning efforts have emphasized the 'ecological prescriptions' of habitat and wildlife restoration, while seeking compatible designs for current and future demand for recreation. In fact, natural area management requires staff to first manage for ecological integrity and then find passive recreation that is compatible with that priority. However, the City of Portland currently lacks a comprehensive planning, design, and management strategy for developing sites in order to expand opportunities for off-road cycling.

Section 7: **References**

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