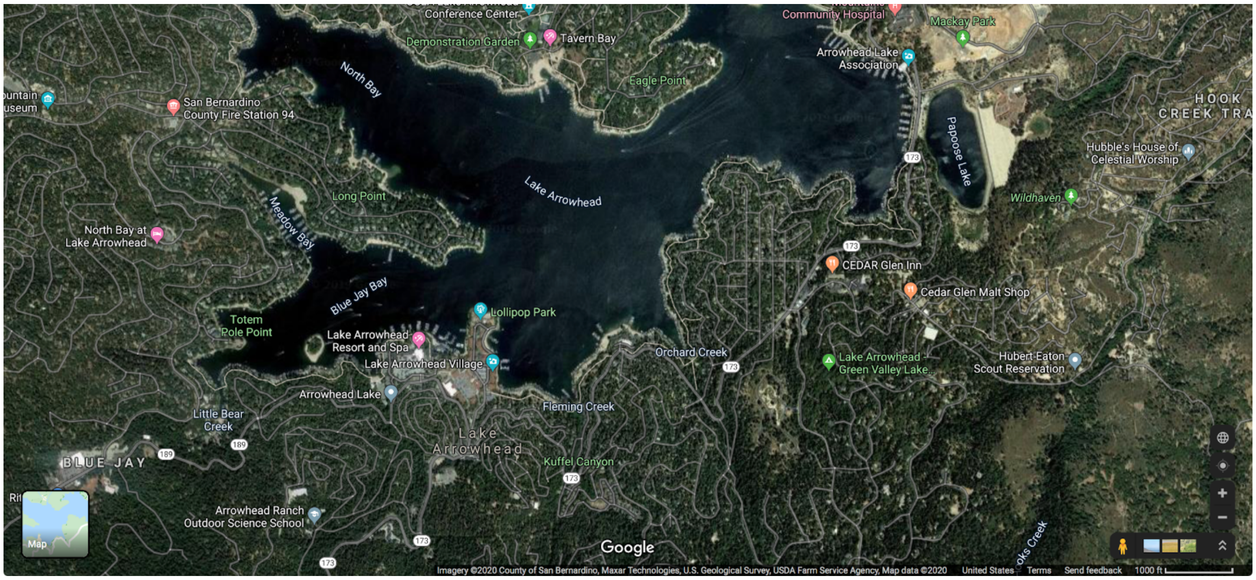

Figure 1. Study Sampling Sites; Area Map

Table 1. Federal, State and Regional Surface Water Quality Regulatory Standards

Water Quality Metric	Standard	Source
Temperature (C)	< 25C	CA State Water Board
Dissolved Oxygen (DO) (mg/L)	>4 mg/L	CA State Water Board, Lahontan Region
pH	6.5-8.5	CA State Water Board, Lahontan Region
Turbidity (NTU)	<100 NTU	CA State Water Board (Fact Sheet)
Conductivity (uS/cm)	150-500 Range <336 ms/cm (Average)	EPA (Range) CA State Water Board (Average)
Nitrate (NO3-) (mg/L)	0.8-2.5 mg/L	San Bernardino Mountains Hooks Creek Objectives
Ammonium (NH4+) (mg/L)	0.02-0.4 mg/L	EPA Aquatic Life Criteria
Total Coliform (TC) (cfu/100mL)	1,000 cfu/100mL	CA State Water Board Objectives
e. Coli (cfu/100mL)	<126 cfu/100mL	EPA Recreational Standards
Enterococcus (cfu/100mL)	<35 cfu/100mL	EPA Recreational Standards

Methods

Water Quality Sampling

Water quality was monitored *in situ* from August 2019 through August 2020 (ongoing) for each catchment (i.e. LBC1, LBC2, BMC, OC) for ammonium (NH4+, mg/L), conductivity (µS/cm), dissolved oxygen (DO, mg/L), stream flow (m/s), pH, nitrate (NO_3^-, mg/L), turbidity (NTU), and water temperature (°C) using ion selective electrode probes and a Vernier Labquest 2 monitor similar to Khatoon et al. (2013), Vega et al. (1998), and Varol et al. (2012). Additional grab samples were collected, immediately placed on ice, and transported to California State University at San Bernardino to test for total Coliform (TC, cfu/100mL), Escherichia Coli (E. Coli, cfu/100mL) and enterococcus (ET). Total Coliform, E. Coli and enterococcus were analyzed using U.S. EPA approved IDEXX methods, Colilert, Colilert-18, Colisure, and Quanti-Tray/2000 and reported to the 95% confidence interval. Grab samples were collected in 1 (L) brown opaque HDPE plastic bottles that were acid washed using EPA protocols (EPA 2003). Samples events occurred at each site bi-weekly during dry, drought conditions and weekly during rainfall and snow melt conditions to identify physicochemical and surface flow trends related to climatic and seasonal changes. Individual sampling events and sample means were compared to federal, state and regional water quality objectives and standards to determine the frequency in which samples met or exceeded these requirements as outlined in Table 1.

Trends to Date

Table 2. Descriptive Statistics Ammonium
*Denotes means and medians exceeding regulatory standards.

Headwater Tributary Water Quality Parameters Descriptive Statistics					
Ammonium (NH_4^+) mg/L	**Statistics**	LBC1	LBC2	BMC	OC
	Mean	0.35	0.32	0.26	0.32
	Median	0.2	0.2	0.1	0.2
	Standard Deviation	0.36	0.43	0.27	0.36
	Variance	0.13	0.18	0.07	0.13
	# of samples	37	38	40	38

Table 3. Descriptive Statistics Nitrate
*Denotes means and medians exceeding regulatory standards.

Headwater Tributary Water Quality Parameters Descriptive Statistics					
Nitrate (NO_3^-) mg/L	**Statistics**	LBC1	LBC2	BMC	OC
	Mean	1.59	0.96	1.17	1.71
	Median	1.15	0.8	1.1	1.5
	Standard Deviation	2.62	0.78	0.90	1.31
	Variance	6.90	0.618	0.814	1.73
	# of samples	37	38	40	38

Table 4. Descriptive Statistics Total Coliform
*Denotes means and medians exceeding regulatory standards.

Headwater Tributary Water Quality Parameters Descriptive Statistics					
Total Coliform (TC) cfu/100mL	**Statistics**	LBC1	LBC2	BMC	OC
	Mean	683.99	643.08	211.94	414.52
	Median	343.2	278.6	122.4	125.9
	Standard Deviation	726.58	740.69	278.62	679.82
	Variance	527927.34	548626.98	77632.61	462158.38
	# of samples	22	24	25	23

Table 4 Notes:
LBC1 Mean: 6% higher than LBC2; 69.1% higher than BMC; 40% than OC
LBC1 Median: 19% higher than LBC2; 65% higher than BMC; 64% higher than OC
LBC2 Mean: -6% lower than LBC1; 68% higher than BMC; 36% higher than OC
LBC2 Median -23% lower than LBC1; 57% higher than BMC; 55% higher than OC

Table 5. Descriptive Statistics E. coli
*Denotes means and medians exceeding regulatory standards.

Headwater Tributary Water Quality Parameters Descriptive Statistics					
E. coli (EC) cfu/100mL	**Statistics**	LBC1	LBC2	BMC	OC
	Mean	**302.46***	**160.62***	28.81	33.72
	Median	106.5	36.95	6.7	14.2
	Standard Deviation	536.47	232.65	75.59	58.90
	Variance	287803.11	54127.38	5714.02	3469.36
	# of samples	22	24	25	23

Table 5 Notes:
LBC1 Mean: 47% higher than LBC2; 91% higher than BMC; 89% higher than OC
LBC1 Median: 66% higher than LBC2; 94% higher than BMC; 87% higher than OC
LBC2 Mean: -88% lower than LBC1; 83% higher than BMC; 80% higher than OC
LBC2 Median: -188% lower than LBC1; 85% higher than BMC; 62% higher than OC

Table 6. Descriptive Statistics Enterococcus
*Denotes means and medians exceeding regulatory standards.

Headwater Tributary Water Quality Parameters Descriptive Statistics					
Enterococcus (ET) cfu/100mL	**Statistics**	LBC1	LBC2	BMC	OC
	Mean	**184.95***	**66.73***	28.76	23.11
	Median	**137.4***	**49.5***	13.3	11.65
	Standard Deviation	164.16	58.01	45.65	23.19
	Variance	26951.36	3365.715	2083.94	538.15
	# of samples	12	12	13	12

Table 6 Notes:
LBC1 Mean: 64% higher than LBC2; 85% higher than BMC; 88% higher than OC
LBC1 Median: 64% higher than LBC2; 91% higher than BMC; 92% higher than OC
LBC2 Mean: -177% lower than LBC1; 57% higher than BMC; 66% higher than OC
LBC2 Median: -177% lower than LBC1; 74% higher than BMC; 77% higher than OC

Table 7. Number of Sampling Periods Exceeding Regulatory Standards Outlined in Table 1.

Sampling Site	Ammonium (NH4+) mg/L	Nitrate (NO3-) mg/L	Total Coliform (TC) cfu/100mL	E. coli (EC) cfu/100mL	Enterococcus (ET) cfu/100mL
LBC1	24.3% n=37	10.8% n=37	22.7% n=22	45.45% n=22	75% n=12
LBC2	28.9% n=38	38.4% n=38	37.5% n=24	33.3% n=24	66.6% n=12
BMC	22.5% n=40	5% n=40	4% n=25	4% n=25	23% n=13
OC	26.3% n=38	15.7% n=38	13% n=23	8% n=23	25% n=12

Trends and Observations

1. Little Bear Creek Site 1 (LBC1) represents the highest percentages of sampling periods that exceed regulatory standards for E. coli and Enterococcus across all perennial tributaries.
2. Little Bear Creek Site 2 (LBC2) represents the highest percentages of sampling periods that exceed regulatory standards for NH4+, NO3-, TC and across all perennial tributaries.
3. Collectively, LBC1 and LBC2 represents the first and second highest percentages of sampling periods that exceed regulatory standards for NO3-, TC, EC, and ET.
4. No sampling locations had means, medians or individual sampling periods that exceeded regulatory standards for temperature, conductivity, dissolved oxygen, pH or turbidity.
5. Multiple sampling periods with >1 metric/parameter exceeding regulatory standards simultaneously.
    a. Although empirically and statically Little Bear Creek is the most impaired of the three perennial streams studied, other tributaries have individual sampling periods

that exceed regulatory standards especially as they apply to NH4+, NO3-, TC, EC, ET.

6. Spikes in nutrients, bacteria-based parameters are associated with precipitation events and during prolonged dry periods.
    a. Suggests year-round impacts already exists.
7. Based on broad peer-reviewed literature, the approved stormwater project moving water from impervious surfaces in Rimforest, under Highway 18 and directly into Little Bear Creek will result in increases in pollution concentrations and eroded soils into this headwater tributary system and downstream, eventually entering Lake Arrowhead.
8. Bioretention areas and other related EPA recommended stormwater BMPs (grass swales, etc.) require constant management and monitoring to remain effective.
    a. Widely accepted literature (30+ years) observes that BMPs do not improve water quality vs. a pre-development natural vegetated area. Instead they mitigate, to a degree, development impacts.
9. The steep slopes present on this landscape where stormwater will be diverted into Little Bear Creek, suggests increases in turbidity (suspended solids including eroded soil particles) in Little Bear Creek. Eroded soils coupled with impervious surfaces have been identified as primary contributors to increases in land-based pollution inputs entering surface water systems.
    a. Pollution inputs including, phosphorus, nitrate, ammonium, coliforms, e. coli and other pathogens adhere to eroded soil particles and are conveyed to surface waterways during stormflow events.
    b. Collectively, these inputs are associated with Harmful Algal Blooms (HABs) that impact both human and ecological health. This is especially concerning during drought conditions characterized by high evaporation rates as these inputs become more concentrated in waterways.
10. Observations at SkyPark CUP NRCS designed BMPs do not suggests water quality improvements related to nutrients.
    a. Downstream impacts to human health in recreational waterways.
    b. Both this site and Lake Arrowhead contribute to surface waters in the Mojave Basin posting economic, social and environmental impacts to other communities.
11. High Quality Water Resources Essential to Community Resiliency.
    a. Social, Economic and Environmental Impacts need to be fully considered due to large % of Mountain Communities considered Disadvantaged by CA OEHHA and DWR (based on census data)
12. In addition to impacts to Lake Arrowhead - Little Bear Creek also contributes (even before LA was developed) to Deep Creek which is a National Wild and Scenic River. There are two drainage points for LA - one on the north shore near the UCLA center (Willow Creek) and to the far east, which is the continuation of Little Bear Creek. Both terminate into Deep Creek, which creates the headwaters of the Mojave River. There are numerous fishing and swimming points along Deep Creek and it is so heavily used the USFS shut portions of it down recently due to high use.
13. Inconsistent Conditional Use Permit (CUP) Applications within community, especially as they relate to the implementation of stormwater BMPs.
    a. In addition to the conditions use permit (CUP) imbalance between this site and Skypark. Multiple tributaries that center Deep Creek (Holcomb, Crab, Sheeps)

and the upper Mojave (near us) are listed on the EPAs 303d list. This raises the question – Is it ok to contribute additional pollution inputs to this hydrological network increasing issues that violate the Clean Water Act? The cost goes to everyone to mitigate.

14. A map and related reports of the Clean Water Act list of 303d impaired streams in this mountain region and downstream (https://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2014_2016.shtml) indicates that Sheep, Crab and to the NE Holcomb, all tributaries to Deep Creek, are all impaired. Additional pollution inputs from Lake Arrowhead via the perennial tributaries that are entering this surface body of water, increasing the impairments and harmful externalities to both public human and ecological health – two factors that the governing bodies of San Bernardino (and their supportive staff and departments) are elected for and required to protect.

Supportive Peer Reviewed Literature

Effectiveness and Limitations to Stormwater Best Management Practices

Establishing relationships between specific landscape activities, climatic conditions, and water quality allows for the identification, design, and implementation of stormwater best management practices (BMPs) that capture surface runoff from the landscape prior to entering surface water resources. BMPs are diverse and may include rain barrels and rain gardens that capture runoff from smaller areas, as well as grass swales, retention ponds, and bioretention areas designed for larger areas and related runoff events. Stormwater BMPs have been implemented on numerous land types and across various spatial extents to protect and improve water quality at headwater streams and along stream segments within a single watershed or river basin. A secondary advantage to implementing BMPs is assisting communities with meeting regulatory requirements by ensuring that specific landscape features or activities within a watershed are not impacting water resources downstream (Gautam et al. 2010, Hunt 2010, Strecker et al. 2001, McNett et al 2010).

Effectiveness of Stormwater Best Management Practices

The selection of a BMP requires careful consideration of site location based on landscape characteristics and the quantity of stormwater runoff during precipitation events. Gautam et al. (2010) suggests that factors influencing stormwater BMP design for specific regions are land use, vegetation, soil type, topography, geology, and climatic factors. In areas with various types of impervious surfaces (i.e. buildings, roads, and parking lots), BMPs are highly variable in their ability to effectively remove pollution inputs from stormwater runoff and protect aquatic biodiversity (Comings et al. 2000; Roy et al. 2014; Gautam et al. 2010; Mallin et al. 2016, McNett et al. 2010). Comings et al. (2000) observed the effectiveness of two wet detention ponds in a developed (i.e. commercial and residential) watershed with 57% impervious cover located in Washington state. The detention ponds improved water quality, however, the pollutant removal efficiency varied resulting in a 20% to 50% reduction of phosphorus and less than 50% removal of trace metals and total suspended solids. When considering BMP effectiveness in improving downstream water quality, Roy et al. (2014) observed the extent to which multiple BMPs (i.e rain barrels and rain gardens) assisted with improving onsite stormflow volume and water quality in suburban catchments when compared to controlled, non-BMP catchments. Although site stormflow was reduced, the variation in BMP types implemented did not significantly reduce conductivity, iron, sulfate, nitrate, and total dissolved phosphorus concentrations downstream from the BMP site, which was deemed harmful to aquatic species. This suggests that the overall improvement of stream health warrants additional treatment of stormwater from impervious surfaces.

Stormwater BMPs can also be designed as transitional zones between impervious surfaces and surface waterways. In an urban coastal region in North Carolina, Mallin et al. (2016) observed if grass swales, curb cuts, and rain gardens were effective in removing fecal coliform bacteria from impervious surfaces entering coastal waterways during rain events. These BMPs not only reduced the pollutant load to estuarine waters, but it also reduced the loading of total suspended solids and stormwater discharge, providing the opportunity for infiltration and groundwater recharge. Results suggest that the removal of pollutant loads and fecal coliform bacteria through the implementation of these BMPs is essential for the protection of both aquatic and human health. In arid regions, water is a limited resource due to high evaporation rates coupled with short hydrologic seasons that provide annual precipitation over a few months. Gautam et al. (2010) suggests that stormwater BMPs designed for these regions should handle high precipitation rates and related flows over short periods of time, minimize sediment and channel erosion, and promote groundwater quality and recharge. In Southern California, Barret (2005) observed the effectiveness of detention basins, vegetated buffer strips and swales, infiltration trenches and basins, and a wet basin in reducing stormwater runoff rates from impervious surfaces. Runoff entering these BMPs were tested for total suspended solids, metals, and nutrients. The vegetated buffer strips and extended detention basins were effective in reducing runoff volume by 30%, while vegetated swales reduced runoff by 47%. Given the highly variable effectiveness of BMPs in mitigating pollution inputs from entering surface water systems, it is important to explore the benefits and limitations of these practices across multiple landscapes and climates as well as their site location within the hydrological network.

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Water Quality: Environmental and Public Health

The environmental degradation of water resources is primarily linked to anthropogenic activities that alter the landscape and introduce excessive pollution inputs into waterways (Singh 2014; Wang et al. 2020; C. Zhang et al. 2019; G. P. Zhang et al. 2013; Zomorodian et al. 2018). In recreational settings, Priskin (2003) notes that a majority of water quality impairments come from the impervious surfaces (i.e. roadways, parking lots, buildings) that are associated with the developed environment. Extensive literature has documented impervious surfaces as the primary conveyance system for terrestrial based pollution entering waterways during storm related runoff events (Arnold and Gibbons 1996; Schuler 1996; Bracbec 2009). Pollution inputs can be highly variable and associated with discharges from land-based and upstream industrial facilities, agricultural and residential based fertilizers, failing septic and sewer systems, and waste from humans and animals (Burkholder et al. 2007; Cahoon et al. 2006; Galfi et al. 2016; Korajkic et al. 2018). Once in waterways, climatic factor (i.e. excessive heat, drought, evaporation) may concentrate the physicochemical (i.e. nutrients, conductivity, dissolved solids, etc.) conditions present in water bodies (Li et al. 2017; Van Vliet and Zwolsman 2008). Collectively, these factors reduce both the quantity and quality of water resources available to support recreational activities while simultaneously threatening public and environmental health.

Of growing concern to recreational, natural resources, and public health agencies is the excessive input of nutrients (i.e. NO3-, NH4+) and bacteria that support harmful algal blooms (HABs) (i.e. cyanobacteria), eutrophication (i.e. excessive nutrients), and hypoxic conditions (i.e. low dissolved oxygen) within waterways. These conditions cause a multitude of public and ecological health issues including skin irritations, respiratory issues, gastroenteritis infections, and liver damage in humans and the bioaccumulation of cyanotoxins in aquatic species (Bello et al. 2017; Butcher & Covington 1995; CAWQ 2020; He et al. 2011; Manganelli et al. 2012; WHO 1999). During warmer seasons, when recreational waters are in high demand, higher water temperatures and the presences of excessive nutrients in waterways lower dissolved oxygen (DO) levels needed to support aquatic species leading to widespread fish kills and creating conditions favorable for HAB outbreaks (Burger et al. 2003; Burkholder et al. 2001; DPH 2019; Gandhi et al. 2017; Matuszak et al. 1997; Missaghi et al. 2017).

These conditions require agencies to issue public health advisories leading to waterways closers in an effort to protect the public from consuming toxic fish and coming into contact with impaired waterways. The Center for Disease Control (CDC) reported that from 2000-2014, 35 states voluntarily reported 140 recreational water impairments which resulted in 4,958 illnesses and two deaths. Of these cases, 80 outbreaks (57%) were associated with enteric pathogens including coliforms and E. coli (CDC 2020a). Anderson et al. (2000) notes that the average annual economic impact of HABs alone in the United States between 1987 and 1992 was over $49.3 million, of which 55% was attributed to cost related to public and environmental health, increasing monitoring/management, and loss of recreation/tourism. Given the highly variable human-environmental contributions to water impairments, it is essential to identify these contributions so that comprehensive management strategies can be developed to mitigate site specific impairments.

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Impervious Surfaces and Surface Water Quality

Urbanization Thresholds and Stream Ecosystem Health

Stream ecosystem functions not only vary in relation to different urban landscape features, they also show considerable variation in response to different levels of urbanization. To characterize the level of development within a watershed and its impacts on in-stream ecological health, numerous studies (Arnold & Gibbons, 1996; Mallin et al., 2001; Schueler, 1994; Schiff &

Benoit, 2007; Wang, 2001) have identified thresholds at which the percentage of a particular land use and land cover within a catchment impacts aquatic habitats. Several studies have used percent impervious surface as an indicator of stream and aquatic species health and concluded that the health of aquatic species begins to decline once the watershed reaches 10 to 15 percent impervious surface coverage. When considering the impacts of residential and suburban development in coastal watershed, Mallin et al. (2001) noted stream impairment at 10 to 20 percent watershed impervious surface. In contrast, Schiff and Benoit (2007) concluded that degradation starts at greater than 5 percent and impairment begins to plateau when the watershed exceeds 10 percent impervious surface. This indicates that no significant changes in stream condition occurred once the watershed reached greater than 10 percent impervious surface. Given these varying results, it is important to consider not only the extent of development but also how these patterns impact the overall health of stream ecosystems that support and sustain aquatic species.

In an attempt to characterize stream ecosystem functions related to different levels of urban development, Meyer et al. (2005) considered the functional characteristics of six tributaries of the Chattahoochee River near Atlanta, Georgia. Variables considered in this study related to catchment land-use types and ecosystem characteristics. Specifically, these variables focused on specific measures of nutrient removal and the amount of fine benthic organic matter (FBOM), which provides an energy source for benthic organisms and microbes. Results indicate that nutrient uptake velocities in ecosystems, such as precipitation and stormwater runoff infiltration into soil profiles, decreased as indicators of urbanization increased, specifically, the percent of catchment covered by high intensity urban development characterized by contiguous impervious surfaces. In addition, the amount of fine benthic organic matter (FBOM) also decreased with increasing urbanization and uptake velocities of nutrients were directly correlated to FBOM. When considering different instream responses to measurements of EIA and TIA, Meyer et al. (2005) noted that channel instability is consistent when the EIA is greater than 10 percent and uniform low summer base flows are observed when TIA is greater than 40 percent. Biological impacts included consistently higher algal blooms when EIA exceeds 5 percent and decreases in fish species quantity and diversity above 4 percent TIA and between 2 to 4 percent EIA.

Schiff and Benoit (2007) explored the impacts of urbanization on streams in the West River watershed located in, New Haven, Connecticut in an attempt to identify the spatial scale of watershed imperviousness and its relationship to water chemistry, macroinvertebrates, and physical habitat. A multiparameter water quality index was used to characterize regional urban NPSP levels. In an effort to address the spatial context of development and impairment, the study compared instream variables to impervious cover at three spatial scales: watersheds, local contributing areas, and streams with an 100-meter vegetative riparian buffers. Water quality parameters included temperature, conductivity, pH, dissolved oxygen (DO), and turbidity. Macroinvertebrates were also sampled once in the spring 1999 at 13 sites, three on the mainstem of the watershed and 10 on tributaries. Results indicate that total impervious area (TIA) in the watershed draining to each macroinvertebrates collection site varied between 0 and 61 percent. Seven of the watersheds had less than 5 percent TIA, five had moderate coverage between 5 percent and 20 percent, and one watershed was highly impervious with a TIA of 60 percent or more. Water quality declined sharply as impervious area increased from 0 to 10 percent and remained in a degraded state beyond the 10 percent imperviousness level. When observing macroinvertebrates health, the authors indicated that biota impairment starts when 5 percent impervious areas in a watershed is reached and a constant level of degradation persist beyond the 10 percent impervious area level. This study confirms pervious findings that the absence of organisms susceptible to habitat degradation occurs above the 10 percent impervious cover with impairment noted at the 5 percent imperviousness area threshold (Schiff & Benoit, 2007).

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Arnold, Chester J. Jr. and C. James Gibbons (1996). Impervious Surface Coverage: The Emergence of a Key Environmental Indicator. *Journal of the American Planning Association*, 62(2), 243-257.

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Schiff, Roy and Gaboury Benoit (2007). Effects of Impervious Cover at Multiple Spatial Scales on Coastal Watershed Streams. *Journal of the American Water Resources Association,* 43(3), 712-730.

Wang, X. (2001). Integrating Water-Quality Management and Land-Use Planning in a Watershed Context. *Journal of Environmental Management,* 61, 25-36.

<u>Peer-Reviewed Literature Related to Impervious Surfaces</u>

Literature supporting reductions or omission of impervious surfaces from watersheds landscapes to reduce adverse impacts to surface water resources.

1. Arnold, Chester J. Jr. and C. James Gibbons (1996). Impervious Surface Coverage: The Emergence of a Key Environmental Indicator. *Journal of the American Planning Association*, 62(2), 243-257.

2. Booth, Derek B. and C. Rhett Jackson. (1997). Urbanization of Aquatic Systems: Degradation Thresholds, Stormwater Detection, and the Limits of Mitigation. *Journal of the American Water Resources Association*, 33(5),1077-1090.
3. Brabec, Elizabeth (2009). Impervious Surfaces and Water Quality: A Review of Current Literature and Its Implications for Watershed Planning. *Journal of Planning Literature*, 16(4), 499-514.
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9. Wang, X. (2001). Integrating Water-Quality Management and Land-Use Planning in a Watershed Context. *Journal of Environmental Management,* 61, 25-36.

Original Email Sent to San Bernardino County Officials

Sent: Monday, January 20, 2020 7:48 PM
To: hedi.duron@lus.sbcounty.gov <hedi.duron@lus.sbcounty.gov>; tom.nievez@Lus.sbcounty.gov <tom.nievez@Lus.sbcounty.gov>; Terri.rahhal@lus.sbcounty.gov <Terri.rahhal@lus.sbcounty.gov>; Supervisor.Rutherford@bos.sbcounty.gov <Supervisor.Rutherford@bos.sbcounty.gov>; lewis.murry@bos.sbcounty.gov <lewis.murry@bos.sbcounty.gov>
Subject: CSUSB Water Quality Research Data - Little Bear Creek COTW Proposed Development

Dear Supervisor Rutherford, Ms. Duron, Mr. Nievez, Ms. Rahhal and Mr. Murray,

I hope this email finds you all doing well. I am contacting you regarding to ongoing research funded by the Water Resources and Policy Initiatives (WRPI) related to water quality in Little Bear Creek; a headwater tributary to Lake Arrowhead located in the San Bernardino National Forest. As you likely know this tributary traverses a watershed drainage area that includes Blue Jay and the proposed Church of the Woods (COTW) project site.

Our research assesses stream physiochemical trends bi-weekly at two sites along Little Bear Creek (upstream of Blue Jay (LBC1) and at Blue Jay (LBC2)) and two additional tributaries entering Lake Arrowhead; Willow Creek and Orchard Creek. Testing has been conducted in both dry and precipitation events in situ since September 2019 to present for dissolved oxygen, turbidity, nitrate (NO3-), ammonium (NH4+), conductivity, pH, temperature, stream flow on a bi-weekly basis with additional lab-based testing for E. coli, total coliform and enterococcus on a monthly basis.

Observations include that episodic spikes in nutrients (NH4+ and NO3-) as well as bacteria are currently present in Little Bear Creek, as well as the other sites entering Lake Arrowhead. Collectively these trends indicate that there are already activities on the landscape related to transportation, tourism, infrastructure (i.e. septic and sewer) and impervious surfaces that are adversely impacting surface water resources in perennial streams entering Lake Arrowhead. More specifically, data to date indicates that LBC1 has exceeded regulatory standards 36% of the sampling periods for NH4+, 63% for NO3-, 20% for total coliform, 40% for E. coli and 67% for enterococcus. The second site, LBC2, has exceeded regulatory standards for 70% of the sampling periods for NH4+, 40% for NO3-, 50% for total coliform, 17% for E. coli and 50% for enterococcus with many of the exceedances occurring simultaneously across multiple metrics. These trends continue to contribute to algal blooms and, if not mitigated, could result in the harmful algal blooms associated with cyanobacteria (blue-green algal blooms) as experienced by Lakes Gregory and Silverwood. Such conditions impact the social, economic and environmental quality of all mountain communities since many of the communities are financially dependent on tourist activities year-round as well as public health and safety, especially as they related to recreational waters.

I would also like to share that recent field research also assessed water quality in the BMPs at SkyPark that were required as part of their CUP permitting process. Trends indicate that while the BMPs were effective in reducing some turbidity, they were ineffective in reducing nutrient loads to Hooks Creek. Consequently, the BMPs ability to effectively mitigate headwater impacts from stormwater flowing over impervious surfaces declined over time.

This is an important finding when considering if the BMPs proposed by the COTW will mitigate impacts related to the proposed development because not only will the excavation of a substantial about of soil and removal of vegetation creates changes to groundwater flows needed to sustain both water quality and quantity entering Lake Arrowhead year-round, it will simultaneously impact surface hydrology. The proposed BMPs have also not been proven, empirically, under similar site and climatic conditions, that they are/can be effective in mitigating downstream impacts in the short or long term. Additionally, it is highly likely, based on numerous peer-reviewed studies and assessments by hydrologists and biological engineers, that the county's proposed, and now approved, stormwater project entering Little Bear Creek will impact water quality as indicated in over 30 years of academic research based on real-world assessments of BMP effectiveness. Simply put, any alterations to the natural landscape create some degree of adverse impacts to downstream water resources.

Given the already approved stormwater project flowing into Little Bear Creek, it does not seem reasonable based on the implementation of verified scientific research methods in this creek system, even comparing it to other, less developed tributaries, that the COTW project will benefit the community across social, economic and environmental metrics because the location, landscape and hydrological alterations of the proposed COTW project, by design, will create adverse impacts to water resources that characterize the mountain communities.

I hope and trust that your backgrounds and commitment to public health and safety will alert you to the danger in setting such precedent, not only in the communities located in a National Forest highly depended on tourism based on natural settings and pristine outdoor quality to support summer and winter activities, but how such decisions can impact communities across San Bernardino County including where you live and or work. Supporting a poorly design project largely based on site location and no inclusion of a comprehensive hydrologic assessments that goes beyond a "one size fits all" approach to stormwater management will allow 1.5% (i.e. the 350 members of the COTW congregation) to impact 98.5% of residents across three mountain communities directly now and for generations to come.

To illustrate the scientific findings related to current water quality, I have attached a presentation of my research findings and would welcome the opportunity to discuss ways to support healthy watershed initiatives using natural resource conservation while also supporting innovative design that benefits all community members and visitors alike.

I welcome an open dialogue and hope that you will fully consider the existing, scientifically verified, realities of the adverse water quality conditions already present in this community prior to the approval and potential development of the COTW project.

Please feel free to reach out to me to discuss this further.

Sincerely,

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Exhibit J

Impervious Surface Coverage

The Emergence of a Key Environmental Indicator

Chester L. Arnold, Jr. and C. James Gibbons

Planners concerned with water resource protection in urbanizing areas must deal with the adverse impacts of polluted runoff. Impervious surface coverage is a quantifiable land-use indicator that correlates closely with these impacts. Once the role and distribution of impervious coverage are understood, a wide range of strategies to reduce impervious surfaces and their impacts on water resources can be applied to community planning, site-level planning and design, and land use regulation. These strategies complement many current trends in planning, zoning, and landscape design that go beyond water pollution concerns to address the quality of life in a community.

Arnold is a Water Quality Educator, and Gibbons a Natural Resource Planning Educator, at the University of Connecticut Cooperative Extension System. They are currently principals in the NEMO Project, which uses geographic information system technology to educate municipal land-use decision-makers about nonpoint source water pollution.

Journal of the American Planning Association, Vol. 62, No. 2, Spring 1996.

Impervious land cover has long been characteristic of urban areas, but has only recently emerged as an environmental indicator. Natural resource planning using impervious surface coverage as a framework can be a pragmatic and effective way of addressing a host of complex urban environmental issues, particularly those related to the health of water resources.

Water resource protection at the local level is getting more complicated, largely due to the recognition of nonpoint source pollution, or polluted runoff, as a major problem. This diffuse form of pollution, now the nation's leading threat to water quality (Environmental Protection Agency 1994), is derived from contaminants washed off the surface of the land by stormwater runoff, and carried either directly or indirectly into waterways or groundwater. As programs directed at nonpoint source control cascade down from federal to state to local governments, the technical complexities involved with such control are further complicated by regulatory and management considerations.

Stormwater runoff problems are nothing new to local land-use decision-makers. However, the principal concern about runoff has always been safety, with the focus on directing and draining water off of paved surfaces as quickly and efficiently as possible. Once off the road and out of sight, stormwater has been largely out of mind—downstream consequences be damned (or dammed). Regulations have been expanded in recent years to include consideration of flooding and erosion, yet these factors fall far short of a comprehensive and effective approach to mitigating the water quality impacts of development.

How do planners and other local officials get a handle on protecting their local water resources? While no magic bullet exists to simplify all the complexities involved, an indicator is emerging from the scientific literature that appears to have all the earmarks of a useful tool for local planners—the amount of impervious, or impenetrable, surface. This article reviews the scientific underpinning, usefulness, and practical application of impervious surface coverage as an urban environmental indicator.

People, Pavement and Pollution

Impervious surfaces can be defined as any material that prevents the infiltration of water into the soil. While roads and rooftops are the most prevalent and easily identified types of impervious surface, other types include sidewalks, patios, bedrock outcrops, and compacted soil. As development alters the natural landscape, the percentage of the land covered by impervious surfaces increases.

Roofs and roads have been around for a long time, but the ubiquitous and impervious pavement we take for granted today is a relatively recent phenomenon. A nationwide road census showed that in 1904, 93 percent of the roads in America were unpaved (Southworth and Ben-Joseph 1995). This changed with the early twentieth century ascendancy of the automobile over the railways, capped by the mid-century massive construction of the interstate highway system, which served to both stimulate and facilitate the growth of suburbia. From that point on, imperviousness became synonymous with human presence—to the point that studies have shown that an areas's population density is correlated with its percentage of impervious cover (Stankowski 1972).

Impervious surfaces not only indicate urbanization, but also are major contributors to the environmental impacts of urbanization. As the natural landscape is paved over, a chain of events is initiated that typically ends in degraded water resources. This chain begins with alterations in the hydrologic cycle, the way that water is transported and stored.

These changes, depicted in figure 1, have long been understood by geologists and hydrologists. As

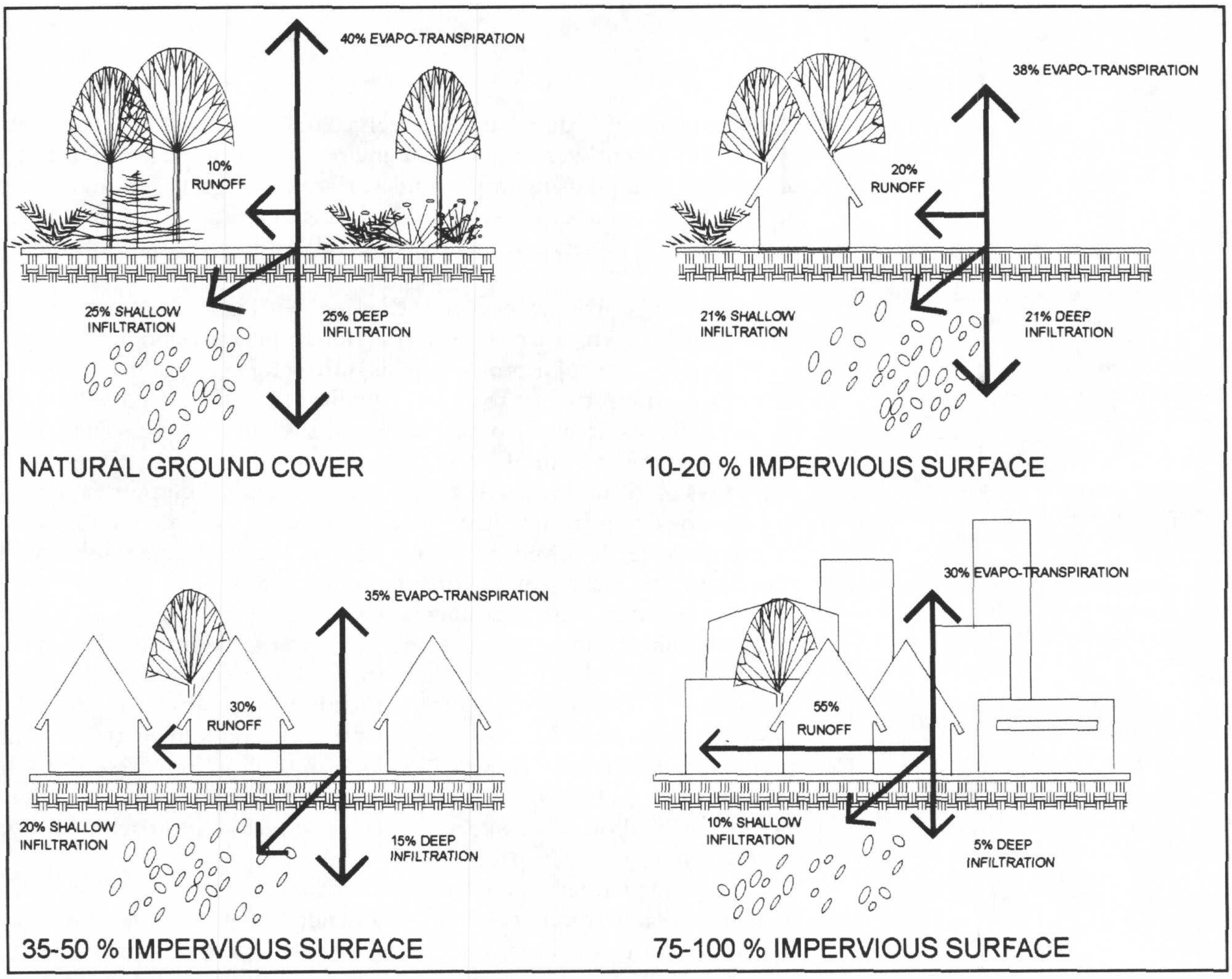

FIGURE 1. Water cycle changes associated with urbanization
Source: Environmental Protection Agency 1993a

impervious coverage increases, the velocity and volume of surface runoff increase, and there is a corresponding decrease in infiltration. The larger volume of runoff and the increased efficiency of water conveyance through pipes, gutters, and artificially straightened channels result in increased severity of flooding, with storm flows that are greater in volume and peak more rapidly than is the case in rural areas (Carter 1961; Anderson 1968; Leopold 1968; Tourbier and Westmacott 1981). The shift away from infiltration reduces groundwater recharge, lowering water tables. This both threatens water supplies and reduces the groundwater contribution to stream flow, which can result in intermittent or dry stream beds during low flow periods (Dunne and Leopold 1978; Harbor 1994).

Hydrologic disruption gives rise to physical and ecological impacts. Enhanced runoff causes increased erosion from construction sites, downstream areas and stream banks. The increased volume of water and sediment, combined with the "flashiness" of these peak discharges, result in wider and straighter stream channels (Arnold, Boison, and Patton 1982). Loss of tree cover leads to greater water temperature fluctuations, making the water warmer in the summer and colder in the winter (Galli 1991). There is substantial loss of both streamside (riparian) habitat through erosion, and in-stream habitat as the varied natural stream bed of pebbles, rock ledges, and deep pools is covered by a uniform blanket of eroded sand and silt (Schueler 1992). Engineered responses to flooding like stream diversion, channelization, damming, and piping further destroy stream beds and related habitats like ponds and wetlands. Finally, with more intensive land uses comes a corresponding increase in the generation of pollutants. Increased runoff serves to transport these pollutants directly into waterways, creating nonpoint source pollution, or polluted runoff.

Major categories of nonpoint source pollutants include pathogens (disease-causing microorganisms), nutrients, toxic contaminants, and debris. Pathogen contamination indicates possible health hazards, resulting in closed beaches and shellfish beds. Overabundance of nutrients such as nitrogen and phosphorous can threaten well water supplies, and in surface waters can lead to algal "blooms" that, upon decaying, rob the waters of life-sustaining oxygen. Toxic contaminants like heavy metals and pesticides pose threats to the health of aquatic organisms and their human consumers, and are often persistent in the environment. Debris, particularly plastic, can be hazardous to animal and human alike, and is an aesthetic concern. Sediment is also a major nonpoint source pollutant, both for its effects on aquatic ecology and because of the fact that many of the other pollutants tend to adhere to eroded soil particles (Environmental Protection Agency 1992, 1993a).

The results of polluted runoff are evident in every corner of the United States. According to the Environmental Protection Agency (1994), nonpoint source pollution is now the number one cause of water quality impairment in the United States, accounting for the pollution of about 40% of all waters surveyed across the nation. The effects of nonpoint source pollution on coastal waters and their living resources have been of particular concern (U.S. House of Representatives 1988; Environmental Protection Agency 1993a). Urban runoff alone ranks as the second most common source of water pollution for lakes and estuaries nationwide, and the third most common source for rivers (Environmental Protection Agency 1994).

As point source pollution is increasingly brought under control, the true impact of urban nonpoint source pollution is being recognized. For instance, even in an urbanized estuary like Long Island Sound, where the major environmental problems have been strongly linked to point source discharges from sewage treatment plants, an estimated 47% of the pathogen contamination is from urban runoff (Long Island Sound Study 1994).

Imperviousness as an Environmental Indicator

Planners wishing to protect their community's water resources against these threats may not know where to begin. The site-specific and diffuse nature of polluted runoff seems to demand extensive technical information on pollutant loadings, hydrologic modeling, and the effectiveness of various management practices. This information is difficult to acquire, not only because of the cost of such studies, but because nonpoint-source-related research and engineering are new and evolving fields.

Enter impervious surfaces. When doing community-level planning, or where detailed site information is unavailable, impervious coverage may often be the most feasible and cost-effective vehicle for addressing water pollution. Two major factors argue for its potential utility to the local planner.

First, imperviousness is integrative. As such, it can estimate or predict cumulative water resource impacts without regard to specific factors, helping to cut through much of the intimidating complexity surrounding nonpoint source pollution. Although impervious surfaces do not generate pollution, they: (1) are a critical contributor to the hydrologic changes that degrade waterways; (2) are a major component of the intensive land uses that do generate pollution; (3) prevent natural pollutant processing in the soil by preventing percolation; and (4) serve as an efficient conveyance system transporting pollutants into the waterways. It is not surprising, then, that research from the past 15 years consistently shows a strong correlation between the imperviousness of a drainage basin and the health of its receiving stream (Klein 1979; Griffin 1980; Schueler 1987; Todd 1989; Schueler 1992; Booth and Reinfelt 1993; Schueler 1994a).

Figure 2 is a stylized graph of this general relationship, showing stream health decreasing with increasing impervious coverage of the watershed, or drainage basin, of the stream. The horizontal lines mark average threshold values of imperviousness at which degradation first occurs (10%), and at which degradation becomes so severe as to become almost unavoidable (30%). These thresholds serve to create three broad categories of stream health, which can be roughly characterized as "protected" (less than 10%), "impacted" (10%–30%), and "degraded" (over 30%).

Thresholds are always controversial and subject to change, yet it is important to note that to date, the threshold of initial degradation in particular seems to be remarkably consistent. The scientific literature includes studies evaluating stream health using many different criteria—pollutant loads, habitat quality, aquatic species diversity and abundance, and other factors. In a recent review of these studies, Schueler (1994a) concludes that "this research, conducted in many geographic areas, concentrating on many different variables, and employing widely different methods, has yielded a surprisingly similar conclusion—stream degradation occurs at relatively low levels of imperviousness (10–20%)" (100). Recent studies also suggest that this threshold applies to wetlands health. Hicks (1995) found a well-defined inverse relationship between freshwater wetland habitat quality and impervious surface area, with wetlands suffering impairment once the imperviousness of their local drainage basin exceeded 10%. Impervious coverage, then, is both a reliable and integrative indicator of the impact of development on water resources.

The second factor in favor of the use of imperviousness is that it is measurable. This enhances its utility both in planning and regulatory applications. (Examples follow in a later section.) Depending on the size of the area being considered and the particular application being applied, a wide range of techniques—with a wide range of price tags—exists for the measurement of impervious coverage.

For site level applications, on-site measurement

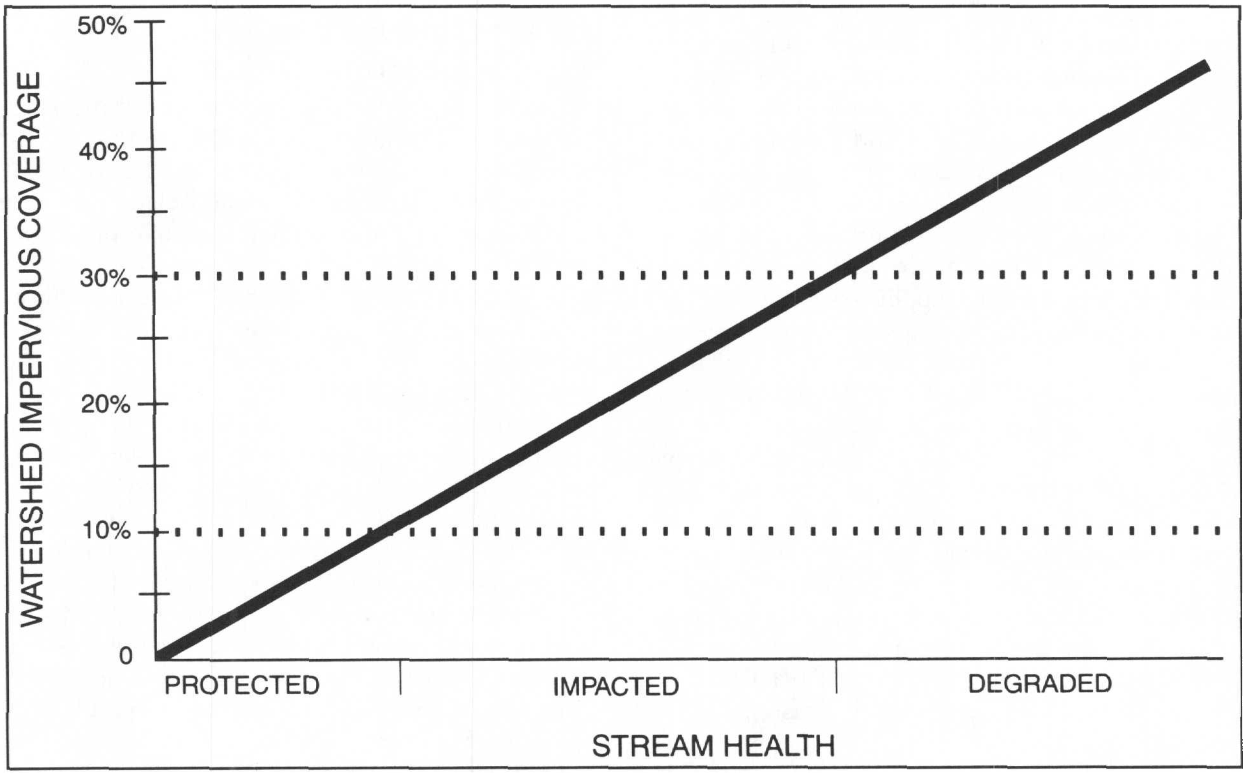

FIGURE 2. Stylized relationship of imperviousness to stream health
Modified from Schueler 1992

using surveying equipment (sometimes as basic as a tape measure) is the most accurate and appropriate method. On the neighborhood level, "windshield" surveys may be appropriate where it is less important to have exact numbers. For community- or regional-scale areas, land cover derived from aerial photographs provides perhaps the best compromise between accuracy and cost. Finally, for applications encompassing even larger areas, remotely-sensed satellite-based land cover can be a viable option. At present, impervious estimates based on satellite data must be calculated by applying literature values of imperviousness to satellite land cover categories. We are currently involved with a remote sensing research project at the University of Connecticut that is attempting to devise a method for directly estimating imperviousness from satellite images (Civco and Arnold 1994).

It is important to note that all of these methods of measurement are increasingly being digitized and presented in the form of computerized maps in a geographic information system, or GIS. This trend eventually will make the information easier to acquire, often at lower expense. Many communities have been unable to afford GIS, and others have been disillusioned at its cost and complexity once they invested in it. Evolution of the technology, however, is making GIS more accessible to local officials every day.

The Components of Imperviousness

To measure and use impervious coverage as a tool for protecting water resources, it is necessary to know how imperviousness is distributed about the landscape. On a scale of increasing refinement, impervious coverage can be broken down by land use, by function within each land use, and by its relative impact on runoff. Each of these pieces of the puzzle can help to target planning and/or regulatory approaches to reducing impervious coverage. As with measurement techniques, the extent to which planners need detailed information on these components depends on the particular application.

The percentage of land covered by impervious surfaces varies significantly with land use. The most frequently cited estimates come from a report by the Soil Conservation Service (1975) (figure 3). "Strip" type

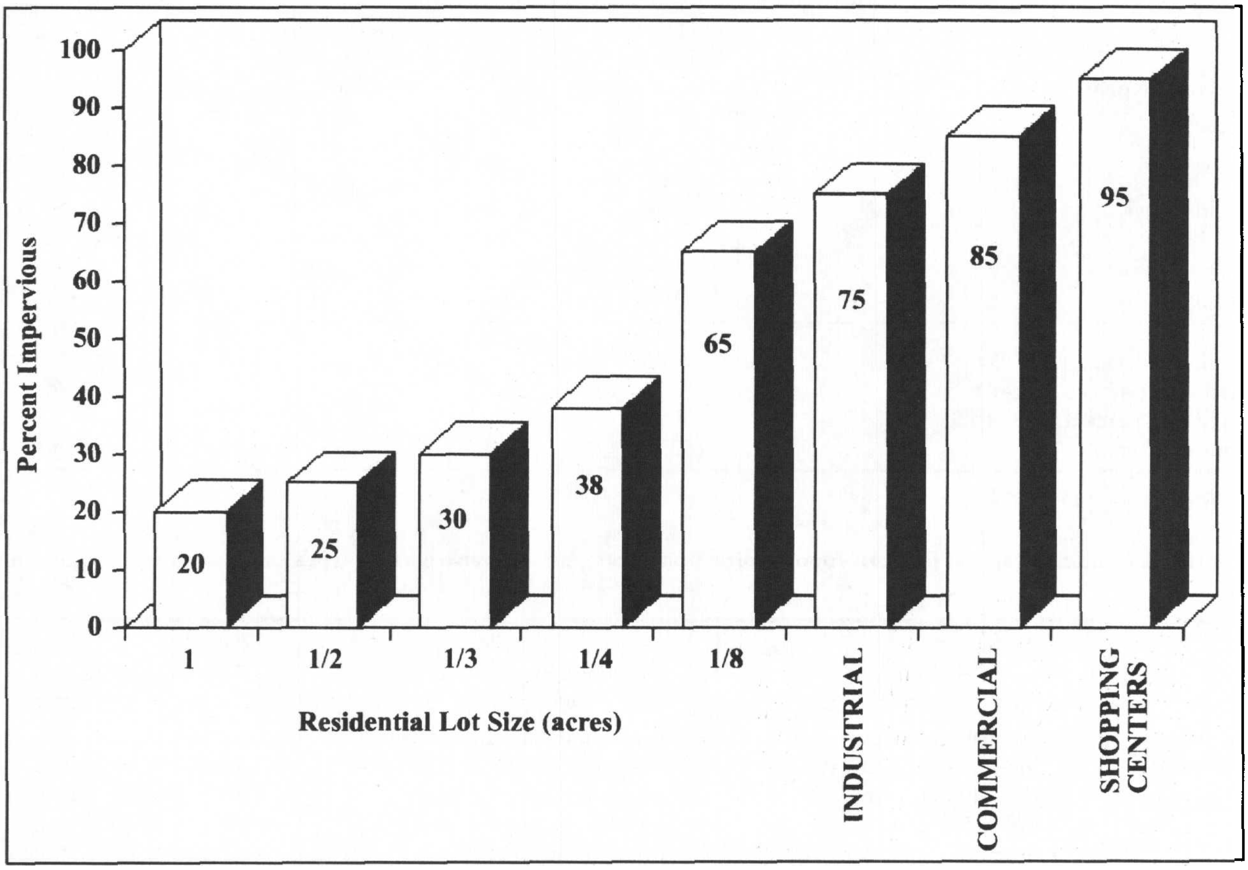

FIGURE 3. Average percentage of impervious coverage by land use
Source: Soil Conservation Service 1975

commercial development tops the chart at around 95% coverage, with other business areas and industrial development lagging slightly behind. In residential areas, there is a wide range of imperviousness that varies predictably with lot size, going from about 20% in one-acre zoning to as high as 65% in one-eighth-acre zoning.

The City of Olympia, Washington, recently conducted a thorough study of impervious coverage in their area. For 11 sites measured, they found coverage values similar to the SCS values, finding four high-density residential developments (3-7 units/acre) to average 40% impervious, four multifamily developments (7-30 units/acre) to average 48% impervious, and three commercial/industrial sites to average 86% impervious coverage (City of Olympia 1995) (table 1).

In addition to the relationship between land use and the total amount of impervious coverage, studies show that all land uses are not equal with regard to the levels of contaminants present in the runoff. As noted, pollutant or land-use-specific studies are relatively new to the scientific community, but existing information supports the common-sense assumption that some land uses are more contaminating than others; for instance, runoff from gasoline stations contains extremely high levels of hydrocarbons and heavy metals (Schueler 1994b).

Recent research from Wisconsin goes one major step further, actually determining the pollutant concentrations from specific categories of impervious surfaces. Using micro-monitoring samplers that collected the runoff from 12 different types of surfaces (e.g., roofs, streets, parking lots, lawns, driveways) in residential, commercial, and industrial areas, Bannerman et al. (1993) were able to show distinct differences in the types and amounts of certain pollutants, depending on the source of the runoff. The study clearly identified streets as the impervious surfaces having the highest pollutant loads for most land-use categories (table 2). Roofs, with the exception of the zinc from industrial roofs, were generally low in pollutant loads, while parking lots had surprisingly moderate

TABLE 1. Site coverage for three land uses in Olympia, Washington

Surface Coverage Type	Average Approximate Site Coverage, % High Density Residential (3-7 units/acre)	Multifamily (7-30 units/acre)	Commercial
1. Streets	16	11	03
2. Sidewalks	03	05	04
3. Parking/driveways	06	15	53
4. Roofs	15	17	26
5. Lawns/landscaping	54	19	13
6. Open space	n/a	34	n/a
Total impervious surface (1-4)	40	48	86
Road-related impervious surface (1-3)	25	31	60
(Road-related as a percentage of total impervious coverage)	(63%)	(65%)	(70%)

Adapted from City of Olympia 1995

TABLE 2. Surfaces exhibiting highest levels of runoff-borne pollutants, out of twelve surface types sampled in selected urban areas in Wisconsin

POLLUTANT	SURFACE Highest levels	Second highest levels	Third highest levels
e. coli (pathogens)	residential feeder streets	residential collector streets	residential lawns
solids (sediment)	industrial collector streets	industrial arterial streets	residential feeder streets
total phosphorous	residential lawns	industrial collector streets	residential feeder streets
zinc	industrial roofs	industrial arterial streets	commercial arterial streets
cadmium	industrial collector streets	industrial arterial streets	commercial arterial streets
copper	industrial collector streets	industrial arterial streets	residential collector streets

Adapted from Schueler 1994d

levels of pollutants. The one unpaved surface monitored, residential lawns, showed high levels of phosphorous, presumably from lawn and garden fertilizers. As this study is augmented by others over time, reliable relationships between pollutant loads and specific landscape components will undoubtedly emerge.

Impervious cover can be further broken down into its functional components. Schueler (1994a) and others point out the two major categories of impervious surface: rooftops, and the transport system (roads, parking lots, driveways, sidewalks). In general, the transport system is the dominant component, reinforcing the concept of an automobile-centric society. In the Olympia study, for instance, the transportation component ranged from 63% for single-family residential development to 70% for commercial development (City of Olympia 1995) (table 1).

One last refinement of the impervious component is its relationship in the landscape to surrounding areas, in the sense of how much of the rainfall onto a given surface is actually conveyed to a stream or stormwater collection system. In general, the rooftop component, which often drains to a lawn or other permeable areas, has less impact than roadways, which typically channel runoff directly to the stormwater system. The Olympia study (1994b) calls this factor the *effectiveness* at producing runoff, and estimates impervious areas in low-density residential developments to be about 40% effective, while those in commercial/industrial areas are close to 100% effective. In theory this concept could be applied to all surfaces—lawns themselves, for instance, can have a significant coefficient of runoff—but to our knowledge this level of refinement has not been researched, nor is it generally needed for most applications.

Imperviousness in Planning: A Framework, Some Examples

By considering the distribution of impervious cover by land use, function, and contribution to runoff, strategies begin to emerge for the reduction of both current and future levels of imperviousness. We suggest that these strategies can be grouped into three basic categories: community or regional planning; neighborhood and site planning, and regulation. Each category presents opportunities to revisit the *status quo* with an eye to water resource protection. Following are some general concepts and specific examples of such opportunities.

Planning at the Community or Regional Level

Land-use planning, even at the town level, need not be based on traditional political boundaries. Increasingly, environmental and natural resource professionals recommend planning based on the organization of natural systems (Environmental Protection Agency 1993c). Ecosystems as an organizational unit have been suggested, but the functional definition of an ecosystem remains elusive.

A more promising trend has been toward using watersheds as planning units (Environmental Protection Agency 1993b). A watershed, or drainage basin, is an area that drains to a common body of water, be it a lake, river, stream, aquifer, or bay. Watersheds have an advantage in that they can be clearly defined as geographic units. In addition, the watershed can be used as a system of organization at any number of scales, from a major basin encompassing several states, to a regional basin involving several municipalities, to a local sub-basin on the neighborhood level.

Thinking in terms of watersheds is particularly appropriate for stormwater management, which, after all, is all about drainage. At the University of Connecticut, we have developed a regional/community-level planning approach that provides an example of the use of both watersheds and impervious coverage. The Nonpoint Education for Municipal Officials (NEMO) project was initiated in 1991 to assist communities in dealing with the complexities of polluted runoff management (Arnold et al. 1993). The project, funded by the United States Department of Agriculture's Cooperative State Research, Education and Extension Service, is run by an interdisciplinary team that includes water quality, natural resource planning, and computer technology expertise. NEMO uses geographic information system (GIS) technology as a tool to educate local land-use decision-makers about the links between their town's land use and its water quality. Natural resource information on waterways and watersheds is combined with satellite-derived, land-cover information, and then displayed on colorful maps created with the GIS.

At the heart of NEMO is an analysis of impervious cover. Literature values for the percentage of impervious cover are applied to satellite land-cover categories to come up with rough estimates for the current level of imperviousness within a town or watershed. These values are averaged and displayed by local drainage basin (average area about one square mile) and categorized according to the protected/impacted/degraded scale of increasing impervious cover previously described and shown in figure 2. The current values are then contrasted with a zoning-based, build-out analysis of imperviousness, again displayed by local subbasin (figure 4). The build-out allows town officials a look into the possible future of their town, not in conventional terms of population or lot coverage, but in

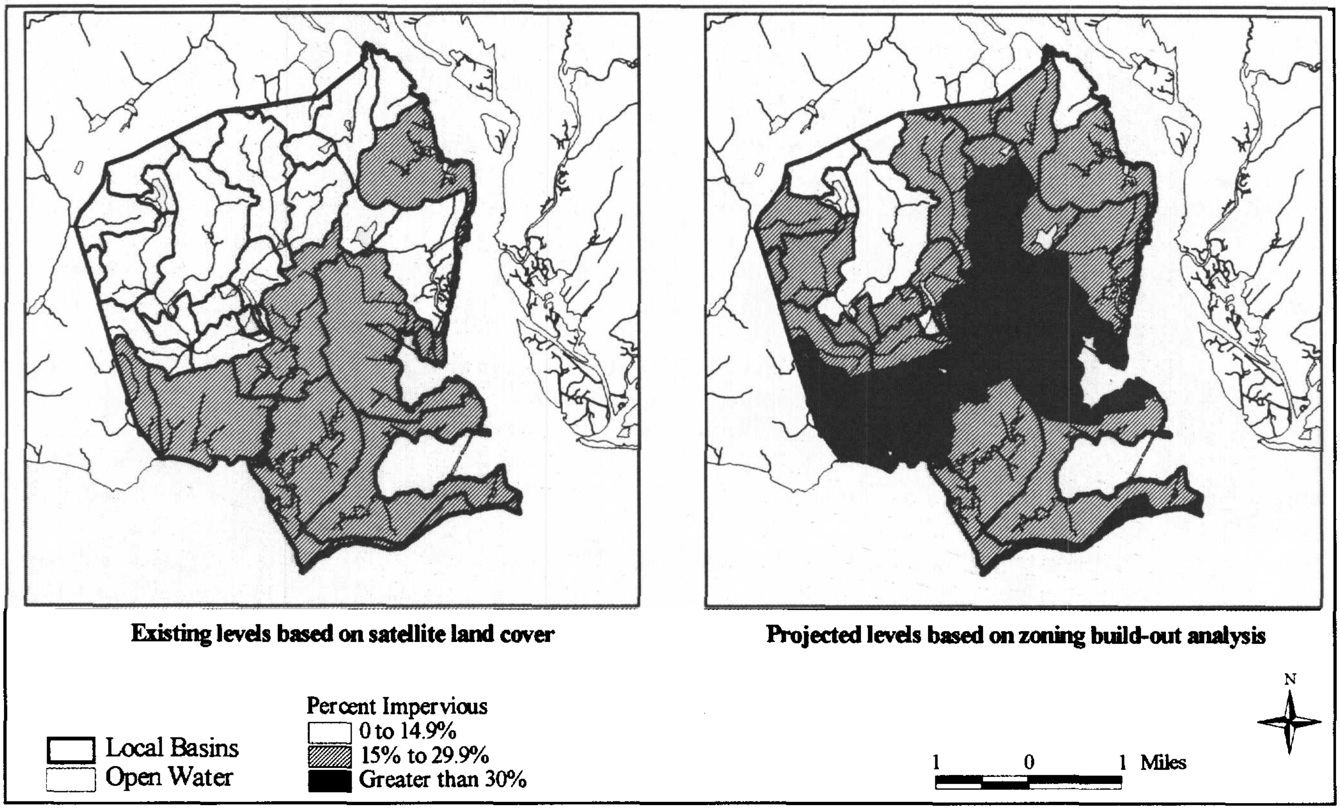

FIGURE 4. Impervious coverage analysis for Old Saybrook, CT

terms of impervious cover—and by inference, the health of their local water resources.

The results of the impervious surface analysis can be used to help guide planning emphasis within each local basin area. For areas in the lower impervious zone, emphasis should be placed on preventive measures that retain existing natural systems, using techniques like open space planning and stream buffers. For areas that are in, or will be in, the "impacted" (10–30%) zone, preventive planning should be accompanied by a focus on site design considerations that reduce runoff and imperviousness. Finally, for areas at (or climbing into) the "degraded" (over 30%) zone, the focus shifts to remediation through pollutant mitigation and resource restoration.

NEMO is one example of the use of imperviousness for broad-based community or regional water resource planning. Similar approaches are beginning to spring up around the country. Schueler (1994a) recommends watershed-based zoning that "is based on the premise that impervious cover is a superior measure to gauge the impacts of growth, compared to population density, dwelling units or other factors." In Alpine Township, Michigan, concern about the effects of urbanization on a formerly productive cold-water trout fishery has prompted researchers from Grand Valley State University to design a watershed-based GIS decision support system for local land-use authorities (Frye and Denning 1995). The system makes use of a number of hydrologic and land-use factors, including impervious surface estimates and zoning-based build-out analyses. In Montgomery County, Maryland, a detailed planning study was done to formulate a land-use strategy to protect the water resources of the Paint Branch stream (Montgomery County MD 1995). The study both measures and projects future impervious surface coverage by subwatershed basin, and uses this information to help guide its recommendations for protective actions.

Each of these efforts contains the elements of impervious cover, subbasin-level analysis, and build-out projections. An even more comprehensive treatment is that undertaken by the City of Olympia, Washington. During 1993 and 1994, Olympia conducted their Impervious Surface Reduction Study (ISRS), from which information is cited repeatedly in this paper. The ISRS Final Report (City of Olympia 1995) contains an impressive and comprehensive body of research, policy analysis, and build-out scenarios, culminating in 19 specific action recommendations. The study concludes that "a 20% reduction [in future impervious cover] is a feasible and practical goal for Olympia and will not require exceptional changes in the Olympia community." The recommended reduction is equal to approximately 600 fewer acres of impervious coverage by the year 2012. Planners wishing to see an example of a comprehensive approach to reducing imperviousness would do well to read the Olympia ISRS report.

As with other natural resource protection efforts, community and watershed-level planning approaches like these are often the most effective way of achieving results. Addressing the issue at this scale provides an overall perspective and rationale for the design and regulatory tools described in the following sections. Site-level considerations are then based not only on the immediate impacts of a given development on the local stream or pond, but also on the site's incremental contribution to the pollution (or protection) of a larger-scale water body or aquifer. Review of site design and stormwater management plans, for instance, can be checked for consistency with goals for the appropriate watershed.

Providing this broad context has the added benefit of allowing for greater flexibility at the site level. Planners can evaluate individual factors like a site's location within the watershed, its land use, and the relative priority of the receiving stream as they relate to the overall plan, rather than applying a rigid and uniform set of requirements to all parcels.

Site-Level Planning

Site planning is perhaps the least-explored approach to reducing water pollution. Kendig (1980) states that "good design begins with an analysis of the natural and environmental assets and liabilities of a site," and that these factors should be the determinants of development patterns. Applying this principle to water resource protection translates to maintaining the natural hydrologic function of a site, through retaining natural contours and vegetation to the maximum extent possible. Consideration of impervious surface is a key element of this overall strategy, extending to all site-level considerations. These include construction practices, design that reduces imperviousness, and design that includes measures to mitigate the effects of the runoff from impervious areas.

Construction activity itself usually creates impervious surface, severely compacting earth with heavy machinery. Although erosion control practices may require procedures for limiting the area of exposed soil and how long it remains exposed, that requirement does not necessarily minimize the amount of compacted soil. Construction should be sequenced with this goal in mind, and it may be necessary later to loosen compacted areas and/or cover them with additional pervious materials (Craul 1995).

From construction, we move to reduction. For virtually all land uses, one of the best design-related opportunities for reducing imperviousness is through the reduction of road widths. As has been seen, roads both constitute a major fraction of a community's impervious coverage, and tend to produce the most pollutant-laden runoff.

The long-established concept of road hierarchies, which relates road size to the intensity of use, has many positive aspects beyond water quality, among them cost reductions and aesthetic benefits. Yet Southworth and Ben-Joseph (1995), in a recent article on the history of residential street design, found that, for a variety of historical and institutional reasons, road hierarchies are often overlooked by local planners and commissions. The authors conclude that an overemphasis on traffic control has resulted in a "rigid, over-engineered approach ... deeply embedded in engineering and design practice." Simple math dictates that for a given length of subdivision road, reduction from a typical 32-foot to a 20-foot width results in a 37.5% reduction in pavement, or over 63,000 square feet (about one and one-half acres) per linear mile. The Olympia study estimated that changing the width of local access roads from 32 to 20 feet would result in an overall 6% reduction in imperviousness for a given development site in their region, that is, six acres less street pavement for a typical 100-acre subdivision (City of Olympia 1994b).

Road surface reduction is a primary reason why clustering is the most pavement-stingy residential design. Large-lot subdivisions, which have long been recognized as being antithetical to most conservation goals (Arendt 1994a, 1994b) generally create more impervious surface and greater water resource impacts than cluster-style housing does. This is true even though the large lots may have less impervious coverage per lot, because the attenuated design requires longer roads, driveways, and sidewalks, which make the overall subdivision parcel more impervious (figure 5). Schueler (1994c) states that cluster development can reduce site imperviousness by 10–50%, depending on lot size and the road network.

In commercial and industrial zones, the focus of design-related reductions in imperviousness shifts to parking areas, the largest component of impervious cover (table 1). Research has shown oversupply of parking to be the rule. Willson (1995), citing his research and that of many others, found that the "golden rule" of 4.0 parking spaces per 1,000 square

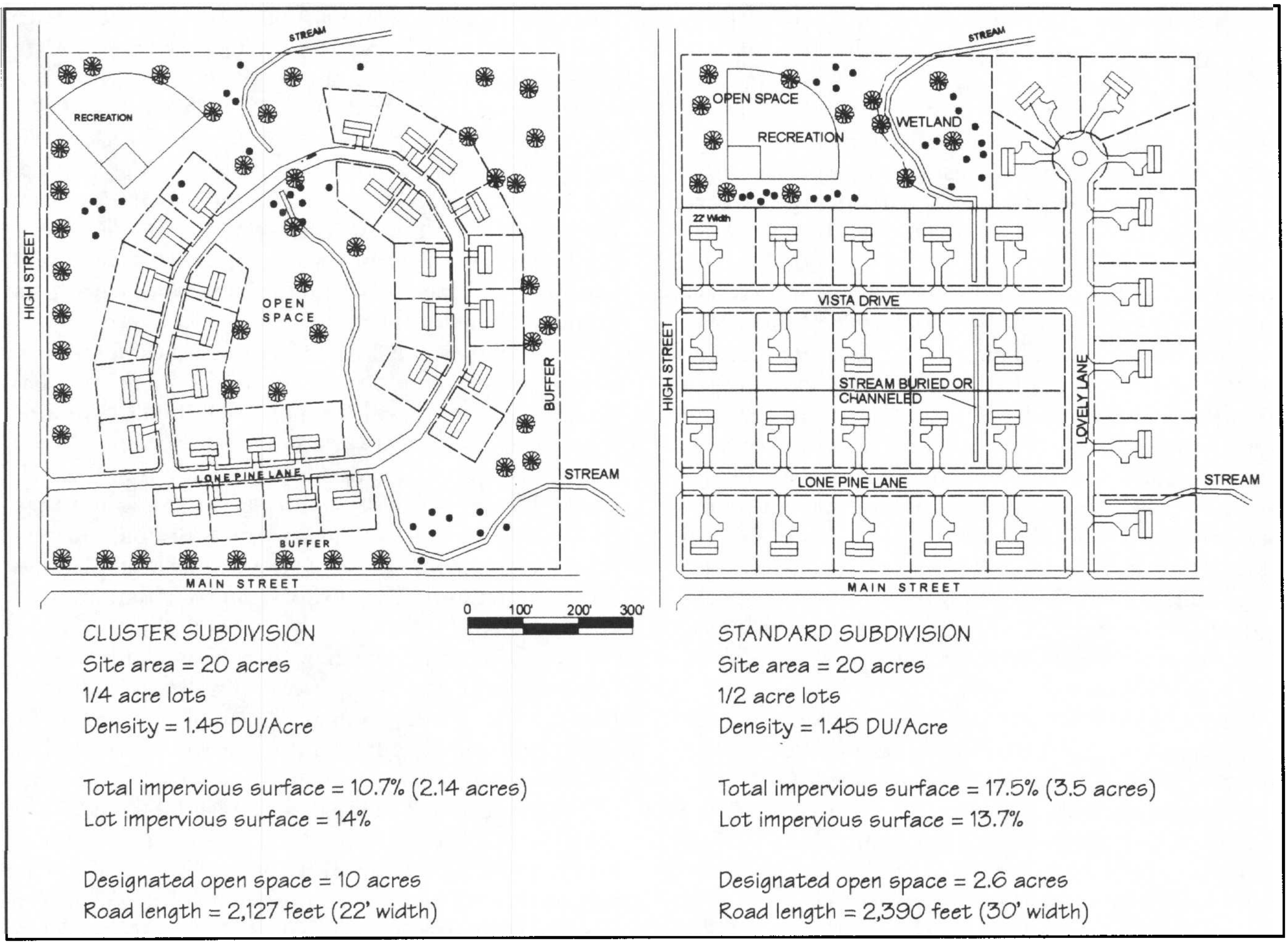

FIGURE 5. Clustering reduces overall site imperviousness.
Source: John Alexopoulos, University of Connecticut

feet of office floor space is often almost twice what is actually needed. Using a generic, medium-sized office building as a hypothetical example, he shows that a typical parking supply ratio of 3.8 results in an extra 55,000 square feet of parking lot, compared to using a more factually-based ratio of 2.5.

The City of Olympia found not only parking oversupply, with vacancy rates of 60–70%, but also developers consistently building parking above minimum ratios, with 51% more parking spaces at their 15 survey sites than were required by zoning (City of Olympia 1994c). This agrees with our observation that, at least in Connecticut, overbuilding of parking appears to be a recent trend with "big box" retail store developers, who typically require at least 5 spaces per 1,000 square feet, principally to meet peak demands on weekends and during the busy period from Thanksgiving to Christmas.

Reductions in parking-related impervious coverage can be attained in ways other than adjusting parking supply ratios. Shoup (1995) suggests that parking can be reduced through economic incentives that effectively end the subsidy provided by employer-paid parking. Employee commuter option programs, mandated by the Clean Air Act Amendments of 1990 in areas of "severe nonattainment" for ozone standards, hold some promise for reducing parking demand. The Olympia study (City of Olympia 1994d) concluded that sharing, joining, or coordinating parking facilities can reduce parking significantly. Finally, vertical garages (above or below ground) can be encouraged, although this alternative can be expensive. Many of these strategies were recently combined in an innovative office park design in Lacey, Washington, where the new 360,000-square-foot headquarters of the state Department of Ecology was designed around a "parking diet" that slashed parking spaces from 1500 to 730 (Untermann 1995).

Imperviousness also has a role in design related to mitigation of polluted runoff. "Best management practices" (BMPs) is the most commonly-used term to describe the wide range of on-site options available to manage stormwater runoff. BMPs are often divided into two major types: those involving structures such as stormwater detention ponds or infiltration trenches, and "nonstructural" practices that usually involve use of vegetated areas to buffer, direct, and otherwise break up the sea of asphalt. Maintenance measures like road sand sweeping and storm drain cleaning are also included.

It is not within the scope of this article to give a thorough discussion of these practices; choosing the correct assemblage is a combination of art and science, and involves many considerations. From the standpoint of imperviousness, however, BMPs can be viewed in terms of how well they replicate the natural hydrological functioning of the site. This perspective puts a premium on restoring infiltration, which has been suggested by Ferguson (1994) and others to be highly preferable to surface detention.

Emphasizing infiltration and nonstructural solutions often comes into conflict with established development practices. Curbing is a good example. Just as Southworth and Ben-Joseph (1995) found the over-engineering of road widths to be ingrained in local practice, our experience has been that to many town engineers, the necessity of curbing is a given. Safety and structural integrity of the road are often given as reasons for curbing, above and beyond its drainage function. Highway engineers in our state, however, have told us that the sole purpose of curbing is to direct stormwater, and even then, it is only truly needed during the unstable construction phase (Connecticut Department of Transportation 1995). In many cases, more pervious alternatives to directing runoff should be investigated. Grassy swales, for instance, might be constructed in the margin created when existing right-of-way widths are retained while road widths are reduced.

Mitigating the impacts of polluted runoff in the "ultra-urban" inner city environment is a particularly thorny issue. Regional approaches like the Olympia ISRS may target these areas for increased impervious cover (City of Olympia 1994a). Growth policies that encourage urban "infilling" may result in higher inner-city imperviousness in order to reduce sprawl and overall imperviousness, region-wide. In effect, this is "clustering" on a regional scale.

Nonetheless, even for these seemingly intractable areas, using imperviousness as a planning framework can be useful. Usually, this involves linking the reduction of impervious surfaces to complementary urban initiatives. Parking is one example. Excess parking can be attacked from many angles other than water quality, including air quality, traffic congestion, promotion of sprawl, and inefficient use of building lots. A parking reduction initiative could be combined with a plan to use the recouped paved area either for active stormwater treatment (infiltration basins, detention ponds) or for more modest stormwater management (vegetated strips). Such a strategy could be combined with the creation of "vest pocket" parks and other green spaces, shown by urban forestry research as having positive sociological and psychological effects on city dwellers (Gobster 1992; Schroeder and Lewis 1992).

Research on the pollutant-processing capability of various types of vegetation suggests a slight twist on parking lot design that may reap large benefits in water quality for urban areas. Parking lots often incorporate landscaped areas, usually in raised beds surrounded by asphalt curbing. However, these vegetated areas can be planted *below* the level of the parking surface, serving as infiltration and treatment areas for runoff (Bitter and Bowers 1994) (figure 6). This idea can be extended to other areas where vegetated "islands" are traditionally used, such as in the middle of cul-de-sac circles.

Another consideration for urbanized areas is pervious alternatives to pavement. This includes various mixes of asphalt with larger pore spaces (e.g., "popcorn" mix), and alternative systems such as open-framework concrete pavers filled with sand or gravel, or turf reinforced with plastic rings. These systems can become clogged with sediment, particularly during construction, but are often a suitable alternative in low traffic areas like emergency roads, driveways, and overflow parking areas. Cahill (1994) asserts that, contrary to common belief, pervious pavement can be used successfully in many places if certain siting, construction, and maintenance practices are followed; for instance, he recommends vacuum cleaning at least twice per year. Granular surfacings are being promoted by some landscape architects as attractive, inexpensive, and more aesthetically-pleasing alternatives to paved pathways and trails (Sorvig 1995).

One last important note about reducing imperviousness through planning and design—it can save money. Savings to both the private and public sectors in reduced construction and infrastructure costs can be considerable. For instance, a recent study done for the Delaware Estuary Program compared the impacts on twelve communities in the watershed, over a 25-year horizon, of a continuation of current "sprawl" development patterns versus the Program-recommended pattern of promoting mixed uses, open space, and

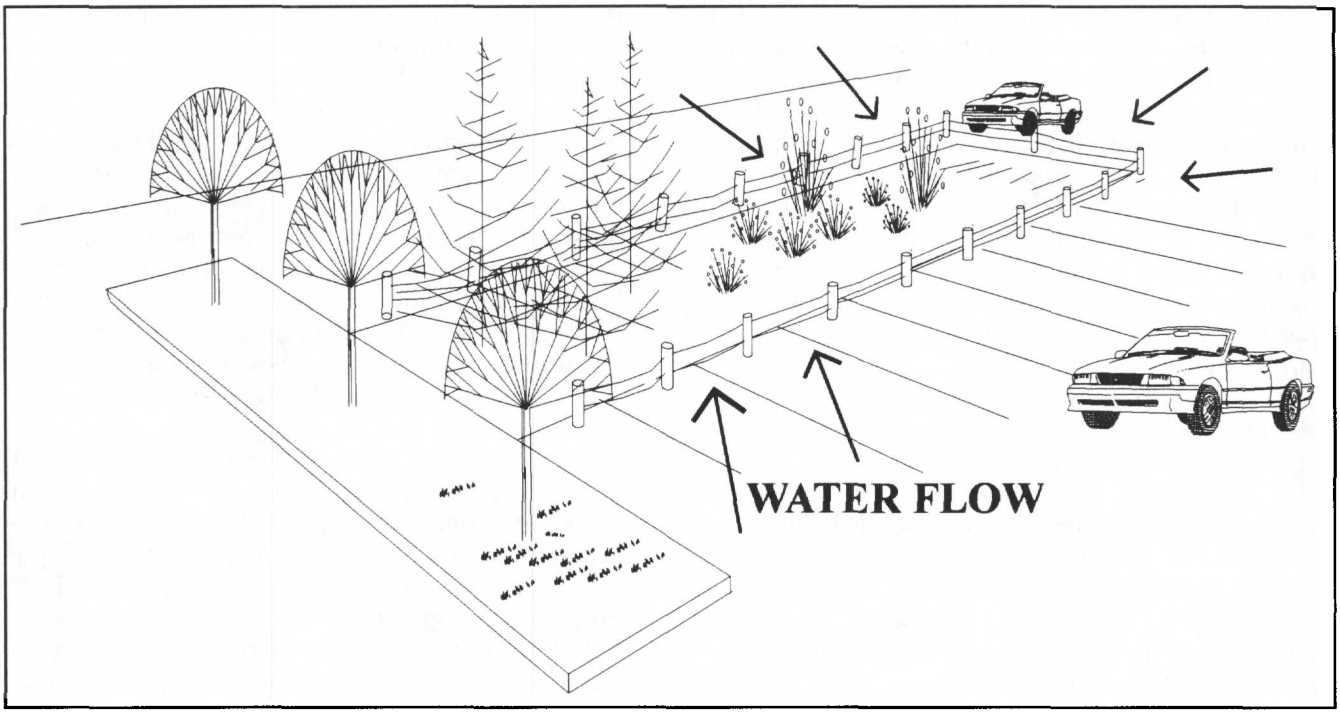

FIGURE 6. Sunken vegetated parking lot "islands" intercept and treat runoff.
Source: John Alexopoulos, University of Connecticut

growth around existing centers. They concluded that for these communities, the less consumptive pattern resulted in savings of $28.8 million in local road costs, $9.1 million in annual water treatment costs, $8.3 million in annual sewer treatment costs, as well as an 8.4% reduction in overall housing costs, and a 6.9% savings in annual costs of local public-sector services (Burchell, Dolphin, and Moskowitz 1995).

The Use of Imperviousness for Regulation

Planning approaches at the community and site level can be complemented with specific applications that give regulatory teeth to planning objectives. To begin with, planners can revisit their current zoning and subdivision requirements with an eye to imperviousness. For instance, many lot coverage limits, particularly for residential uses, refer to rooftops but do not include parking space, sidewalks, and driveway coverage.

Impervious cover lends itself well to zoning that uses performance standards. In fact, Kendig (1980) defines performance zoning as that which regulates development on the basis of four fundamental measures of land-use intensity, one of which is the impervious surface ratio. Jaffe (1993), in a critical assessment of performance-based zoning, concludes that "Kendig's recreational and impervious surface ratios are especially effective in achieving local environmental objectives for stormwater management and groundwater recharge." Performance zoning has the added effect of encouraging mixed uses, which generally result in less impervious coverage and less pollution, by reducing roads and vehicle traffic.

Community-wide applications encompassing large areas with varied land use will require sliding scales of impervious coverage limits that depend on the location, size, and type of use. Such standards have been in place in some Florida communities for almost a decade (American Planning Association Zoning News 1989). More recently, ordinances limiting impervious cover have been enacted in Austin and San Antonio, Texas, driven by concern about pollution of the area's major drinking water aquifer (City of Austin 1992; City of San Antonio 1995).

In instances where protection of a particularly important resource is desired, strict limits on impervious coverage may be imposed. Such is the case in Brunswick, Maine, where a "coastal protection" zone was created for areas draining to Maquoit Bay, site of shellfish beds critically important to the town. The special zone has certain stringent performance standards, among them a maximum impervious-surface lot coverage of 5%. This coverage includes ". . . buildings, roads, driveways, parking areas, patios, and other similar surfaces" (Town of Brunswick 1991). In this case, the very low impervious limit was feasible because the total area affected was fairly small, the use was largely residential, and the specific pollutant of concern was nitrogen emanating from septic systems, resulting in zoning that called for a minimum lot size of one unit per five acres. This "down-zoning" approach, which has also been used in the Buttermilk Bay area in Massachusetts (Horsley and Witten 1991), is practicable for small areas with septic-related concerns, but if applied over large areas, can lead in the long run to promotion of sprawl.

Strict limits may be appropriate, yet in practice they can result in the need for complicated exemption provisions, or even raise the specter of private property rights takings (Land Use Law and Zoning Digest 1995; Ross 1995; Settle,Washburn, and Wolfe 1995). One method for "softening" the concept of limits is to allow for flexibility on the site level. In this scenario, an ordinance setting a limit (or goal) for a site's impervious coverage would require more stringent on-site stormwater treatment when the limit is exceeded. This type of approach will undoubtedly become more common as the information base on removal efficiencies of various treatment measures expands. Another type of flexibility comes from applying performance standards to specific elements of imperviousness within the landscape. In their discussion of next steps, the Olympia study (City Of Olympia 1995) cites the development of performance-based standards for sidewalks, parking, and landscaping "to encourage innovation and provide flexibility in meeting impervious surface reduction goals."

One practical regulatory application of impervious coverage is for stormwater utility assessment, an "impact fee" that is growing in use in urban areas of the country as a way of paying for the treatment and control of polluted runoff. Impervious surface has long been a key determinant in mathematical models that predict the volume of runoff from a given piece of land. Stormwater utility assessments have taken the lead from these models in using imperviousness as a basis for a utility rate structure that fairly distributes the cost of treatment according to a property's contribution to runoff.

Such systems are now in place in many areas, including Kansas City, Missouri; Kitsap County, Washington; and throughout the state of Florida. This type of application requires a community-wide assessment of impervious coverage, and a wide range of techniques is being used. In Kansas City, rate structures are based on digitized high-resolution orthorectified aerial photos (Murphy 1995), while in Florida they are based on statistical surveys of area lots (Livingston 1995). The Kitsap County, Washington, Comprehensive Surface and Stormwater Management Program, established in 1994, creates a rate structure based on an "equivalent service unit" equal to the average estimated amount of impervious surface area on a single-family residential parcel (Kitsap County 1994).

Such programs not only raise funds for mitigation of adverse impacts, but also, by attaching a cost to imperviousness, provide an economic incentive to reduce it. Apparently, this effect is beginning to be seen in Florida, where the cost savings associated with lower stormwater utility fees have provided the impetus for reduction of impervious cover during site redevelopment (Livingston 1995).

Integrating Stormwater Control into Community Planning

The strategies described above demonstrate that for the planner, imperviousness can provide a useful framework for addressing the impacts of urbanization on water resources. But the advantage of this approach goes beyond any specific application. We have found that working with a town on water resource protection often leads to related natural resource issues like open space preservation and forest management. Our recent experience with NEMO has taught us that framing water issues largely in terms of imperviousness serves to expand the range of these connections.

Once water pollution is linked to impervious coverage and its various components, it has a way of insinuating itself into issues currently "on the table" in town. Road widths and curbing may be subjects of town debate about cost or neighborhood character. Parking and landscaping requirements for commercial zones may be undergoing reexamination for aesthetic reasons. The appropriateness of "big box" retailers may be a hot topic, with arguments centered around traffic congestion and the impact on local merchants. An open space plan may be in the formative stages, or the use of stream buffers being questioned. Citizens may be interested in naturalistic landscaping, water conservation, or volunteer monitoring of local waterways. These typical local debates, drawn from towns working with the NEMO Project, now have elements of water quality and impervious surface reduction as part of the mix. And through these debates, the subject of water quality in the community is extended beyond land-use-related staff and boards to include engineering and public works departments, land trusts and other nonprofits, and citizens.

Cross connections of this type are an important key to ensuring the implementation of any planning initiative. For the professional planner, they create opportunities to reinforce complementary planning concepts from several different angles. Beyond the well-established concept of planning and designing with nature (McHarg 1969), there are many relatively recent themes in transportation, subdivision design, and landscape architecture that go hand-in-glove with the reduction of impervious surfaces. Performance zoning is one example. Another is neotraditional residential design, which champions styles of development patterned after the traditional New England village in order to foster a sense of community (Duany and Plater-Zyberk 1991). The open space subdivision designs promoted by Arendt (1994b) for land conservation are also a good fit. On another front, residential street layouts promoting "traffic calming" for a variety of safety, aesthetic, and sociological benefits (Hoyle 1995; Ben-Joseph 1995) could easily incorporate pavement reduction. Landscape architects are calling for more naturalistic schemes that follow the natural contours and make use of low-maintenance, drought-resistant plants (Ash 1995). Planners should seize the opportunity to "piggy-back" water quality with these complementary initiatives, making sure to explicitly incorporate the reduction of paved surfaces and their impacts into official policy, plans, and procedures.

The other advantage of the cross-cutting nature of water resource protection in general, and imperviousness specifically, is that it seems to make sense to the average citizen. Reduction of paved areas is one of relatively few planning initiatives that "plays" at all levels, from the suburban driveway to the big box parking lot, and even to the Chief Justice of the Supreme Court, who recognized the link between the growth of paved surfaces and increased runoff (in *Dolan v. City of Tigard*) (Merriam 1995).

From our standpoint as educators, this feature is critical to the success of any local planning initiative. Education of citizens and local officials on the issues is a necessary and integral part of the process of changing land-use procedures. Volunteer commissioners on local land-use boards are particularly important. In our experience, almost any narrowly-framed issue or problem (environmental or otherwise) brought before busy city, town, or county boards is already operating with two strikes against it. Few issues are isolated, yet they are frequently presented to communities as such, reflecting not the nature of community planning but that of regulatory agencies. A regional planner we work with has called this the "environmental flavor of the month" syndrome.

The result is that even legally mandated initiatives may be doomed to failure by the sheer inertia involved in integrating new and complex information into the busy world of local land-use decision-making. Framing the issue of nonpoint source pollution in terms of imperviousness, although it may be a bit simplistic, appears to be an effective way of enabling local decision-makers to grasp the issue sufficiently to take action.

Conclusion

Water pollution is getting more complex, while at the same time the responsibility for water resource protection is shifting toward local authorities. The use of impervious surface coverage as an environmental indicator can assist planners to construct a game plan to protect their community's natural resources.

Imperviousness integrates the impacts of development on water resources, so it can help to cut through much of the complexity. It is measurable, and so appropriate for a wide range of planning and regulatory applications. It is a cross-cutting feature that is a frequently hidden, but nonetheless substantial, component of many current trends in road, neighborhood, and landscape design, so it can be used as a reinforcing connection between seemingly unrelated planning initiatives. Finally, the basic tenets of reducing imperviousness—retaining the natural landscape, minimizing pavement, promoting infiltration to the soil—are simple concepts that can be understood by a community and its residents.

Impervious cover is rarely specifically identified or addressed in community goals, policies, or regulations. It should be. In this article, we have tried to facilitate the use of this indicator by (1) reviewing the scientific literature to provide a comfort level with its appropriateness; (2) creating a framework for its use in overall planning, site-level planning, and regulation; and (3) providing real-world examples of such applications. With imperviousness as a foundation, planning that begins with water resources often leads to character, design, and aesthetic issues that, taken together, define much of the overall quality of life in a community.

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Exhibit K

Article 1

Feature article from Watershed Protection Techniques. 1(3): 100-111

The Importance of Imperviousness

The emerging field of urban watershed protection often lacks a unifying theme to guide the efforts of its many participants—planners, engineers, landscape architects, scientists, and local officials. The lack of a common theme has often made it difficult to achieve a consistent result at either the individual development site or cumulatively, at the watershed scale.

In this article a unifying theme is proposed based on a physically defined unit: imperviousness. Imperviousness here is defined as the sum of roads, parking lots, sidewalks, rooftops, and other impermeable surfaces of the urban landscape. This variable can be easily measured at all scales of development, as the percentage of area that is not "green."

Imperviousness is a very useful indicator with which to measure the impacts of land development on aquatic systems. Reviewed here is the scientific evidence that relates imperviousness to specific changes in the hydrology, habitat structure, water quality and biodiversity of aquatic systems. This research, conducted in many geographic areas, concentrating on many different variables, and employing widely different methods, has yielded a surprisingly similar conclusion: stream degradation occurs at relatively low levels of imperviousness (~10%). Most importantly, imperviousness is one of the few variables that can be explicitly quantified, managed and controlled at each stage of land development. The remainder of this article details the relationship between imperviousness and stream quality.

The Components of Imperviousness

Imperviousness represents the imprint of land development on the landscape. It is composed of two primary components: the *rooftops* under which we live, work and shop, and the *transport* system (roads, driveways, and parking lots) that we use to get from one roof to another. As it happens, the transport component now often exceeds the rooftop component in terms of total impervious area created. For example, transport-related imperviousness comprised 63 to 70% of total impervious cover at the site in 11 residential, multifamily and commercial areas where it had actually been measured (City of Olympia, 1994b). This phenomenon is observed most often in suburban areas and reflects the recent ascendancy of the automobile in both our culture and landscape. The sharp increases in per capita vehicle ownership, trips taken, and miles travelled have forced local planners to increase the relative size of the transport component of imperviousness over the last two decades.

Traditional zoning has strongly emphasized and regulated the first component (rooftops) and largely neglected the transport component. While the rooftop component is largely fixed in zoning, the transport component is not. As an example, nearly all zoning codes set the maximum density for an area, based on dwelling units or rooftops. Thus, in a given area, no more than one single family home can be located on each acre of land, and so forth.

Thus, a wide range in impervious cover is often seen for the same zoning category. For example, impervious area associated with medium density single family homes can range from 20% to nearly 50%, depending on the layout of streets and parking. This suggests that significant opportunities exist to reduce the share of imperviousness from the transport component.

Imperviousness and Runoff

The relationship between imperviousness and runoff may be widely understood, but it is not always fully appreciated. Figure 1 illustrates the increase in the site runoff coefficient as a result of site impervious cover, developed from over 40 runoff monitoring sites across the nation. The runoff coefficient ranges from zero to one and expresses the fraction of rainfall volume that is actually converted into storm runoff volume. As can be seen, the runoff coefficient closely tracks percent impervious cover, except at low levels where soils and slope factors become more important. In practical terms, this means that the total runoff volume for a one-acre parking lot (Rv = 0.95) is about 16 times that produced by an undeveloped meadow (Rv = 0.06).

To put this in more understandable terms, consider the runoff from a one-inch rainstorm (see Table 1). The total runoff from a one-acre meadow would fill a standard size office to a depth of about two feet (218 cubic feet). By way of comparison, if that same acre was completely paved, a one-inch rainstorm would completely fill your office, as well as the *two* next to it. The peak discharge, velocity and time of concentration of stormwater runoff also exhibit a striking increase after a meadow is replaced by a parking lot (Table 1).

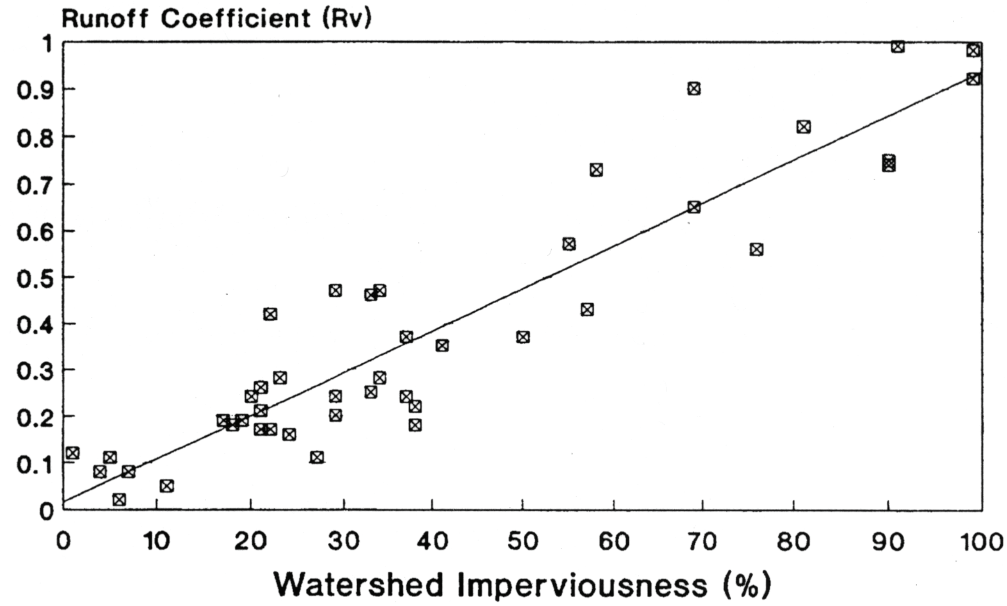


Figure 1: Watershed Imperviousness and the Storm Runoff Coefficient

Because infiltration is reduced in impervious areas, one would expect groundwater recharge to be proportionately reduced. This, in turn, should translate into lower dry weather stream flows. Actual data, however, that demonstrate this effect is rare. Indeed, Evett *et al.* (1994) could not find any statistical difference in low stream flow between urban and rural watersheds after analyzing 16 North Carolina watersheds. Simmons and Reynolds (1982) did note that dry weather flows dropped 20 to 85% after development in several urban watersheds in Long Island, New York.

It should be noted that transport-related imperviousness often exerts a greater hydrological impact than the rooftop-related imperviousness. In residential areas, runoff from rooftops can be spread out over pervious areas, such as backyards, and rooftops are not always directly connected to the storm drain system. This may allow for additional infiltration of runoff. Roads and parking lots, on the other hand, are usually directly connected to the storm drain system.

Table 1: Comparison of One Acre of Parking Lot Versus One Acre of Meadow in Good Condition

Runoff or Water Quality Parameter	Parking Lot	Meadow
Curve number (CN)	98	58
Runoff coefficient	0.95	0.06
Time of concentration (minutes)	4.8	14.4
Peak discharge rate (cfs), 2 yr., 24 hr. storm	4.3	0.4
Peak discharge rate (cfs), 100 yr. storm	12.6	3.1
Runoff volume from one-inch storm (cubic feet)	3450	218
Runoff velocity @ 2 yr. storm (feet/second)	8	1.8
Annual phosphorus load (lbs/ac./yr.).	2	0.50
Annual nitrogen load (lbs/ac./yr.).	15.4	2.0
Annual zinc load (lbs/ac./yr.)	0.30	ND

Key Assumptions:
Parking lot is 100% impervious with 3% slope, 200 feet flow length, Type 2 Storm, 2 yr. 24 hr. storm = 3.1 inches, 100 yr. storm = 8.9 inches, hydraulic radius = 0.3, concrete channel, and suburban Washington ‘C’ values.
Meadow is 1% impervious with 3% slope, 200 foot flow length, good vegetative condition, B soils, and earthen channel.

Imperviousness and the Shape of Streams

Confronted by more severe and more frequent floods, stream channels must respond. They typically do so by increasing their cross-sectional area to accommodate the higher flows. This is done either through widening of the stream banks, downcutting of the stream bed, or frequently, both. This phase of channel instability, in turn, triggers a cycle of streambank erosion and habitat degradation.

The critical question is at what level of development does this cycle begin? Recent research models developed in the Pacific Northwest suggest that a threshold for urban stream stability exists at about 10% imperviousness (Booth, 1991; Booth and Reinelt, 1993) (Figure 2). Watershed development beyond this threshold consistently resulted in unstable and eroding channels. The rate and severity of channel instability appears to be a function of sub-bankfull floods, whose frequency can increase by a factor of 10 even at relatively low levels of imperviousness (Hollis, 1975; Macrae and Marsalek, 1992; Schueler, 1987).

A major expression of channel instability is the loss of instream habitat structures, such as the loss of pool and riffle sequences and overhead cover, a reduction in the wetted perimeter of the stream and the like. A number of methods have been developed to measure the structure and quality of instream habitat in recent years (Galli, 1993; Gibson *et al.*, 1993; Plafkin *et al*., 1989). Where these tools have been applied to urban streams, they have consistently demonstrated that a sharp threshold in habitat quality exists at approximately 10 to 15% imperviousness (Booth and Reinelt, 1993; Galli, 1994; Shaver *et al*., 1995). Beyond this threshold, urban stream habitat quality is consistently classified as poor.

Imperviousness and Water Quality

Impervious surfaces collect and accumulate pollutants deposited from the atmosphere, leaked from vehicles or derived from other sources. During storms, accumulated pollutants are quickly washed off and rapidly delivered to aquatic systems.

Monitoring and modeling studies have consistently indicated that urban pollutant loads are directly related to watershed imperviousness. Indeed, imperviousness is the key predictive variable in most simulation and empirical models used to estimate pollutant loads. For example, the Simple Method assumes that pollutant loads are a direct function of watershed imperviousness (Schueler, 1987), as imperviousness is the key independent variable in the equation.

Threshold Limits for Maintaining Background Pollutant Loads

Suppose that watershed runoff drains into a lake that is phosphorus-limited. Also assume that the present background load of phosphorus from a rural land use amounts to 0.5 lbs/ac/yr. The Simple Method predicts that the post-development phosphorus load will exceed background loads once watershed imperviousness exceeds 20 to 25% (Figure 3), thereby increasing the risk of nutrient over-enrichment in the lake.

Urban phosphorus loads can be reduced when urban stormwater treatment practices are installed, such as stormwater ponds, wetlands, filters or infiltration practices. Performance monitoring data indicates that stormwater practices can reduce phosphorus loads by as much as 40 to 60%, depending on the practice selected. The impact of this pollutant reduction on the post-development phosphorus loading rate from the site is shown in Figure 3. The net effect is to raise the phosphorus threshold to about 35 to 60% imperviousness, depending on the performance of the stormwater practice installed. Therefore, even when effective practices are widely applied, a threshold of imperviousness is eventually crossed, beyond which predevelopment water quality cannot be maintained.

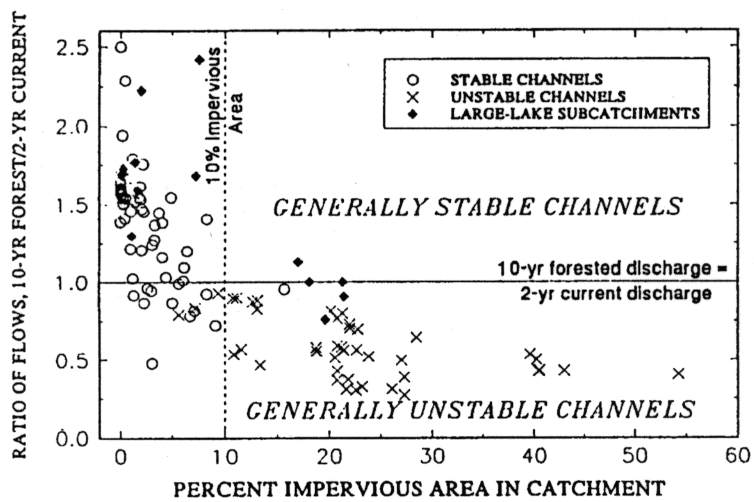


Figure 2: Channel Stability as a Function of Imperviousness (Booth and Reinelt, 1993)

Imperviousness and Stream Warming

Impervious surfaces both absorb and reflect heat. During the summer months, impervious areas can have local air and ground temperatures that are 10 to 12 degrees warmer than the fields and forests that they replace. In addition, the trees that could have provided shade to offset the effects of solar radiation are absent.

Water temperature in headwater streams is strongly influenced by local air temperatures. Galli (1991) reported that stream temperatures throughout the summer are increased in urban watersheds, and the degree of warming appears to be directly related to the impervious cover of the contributing watershed. He monitored five headwater streams in the Maryland Piedmont over a six-month period, each of which had different levels of impervious cover (Figure 4). Each of the urban streams had mean temperatures that were consistently warmer than a forested reference stream, and the size of the increase (referred to as the delta-T) was a direct function of watershed imperviousness. Other factors, such as lack of riparian cover and ponds, were also demonstrated to amplify stream warming, but the primary contributing factor appeared to be watershed impervious cover (Galli, 1991).

Imperviousness and Stream Biodiversity

The health of the aquatic ecosystem is a strong environmental indicator of watershed quality. A number of research studies have recently examined the links between imperviousness and the biological diversity in streams. Some of the key findings are summarized in Table 2.

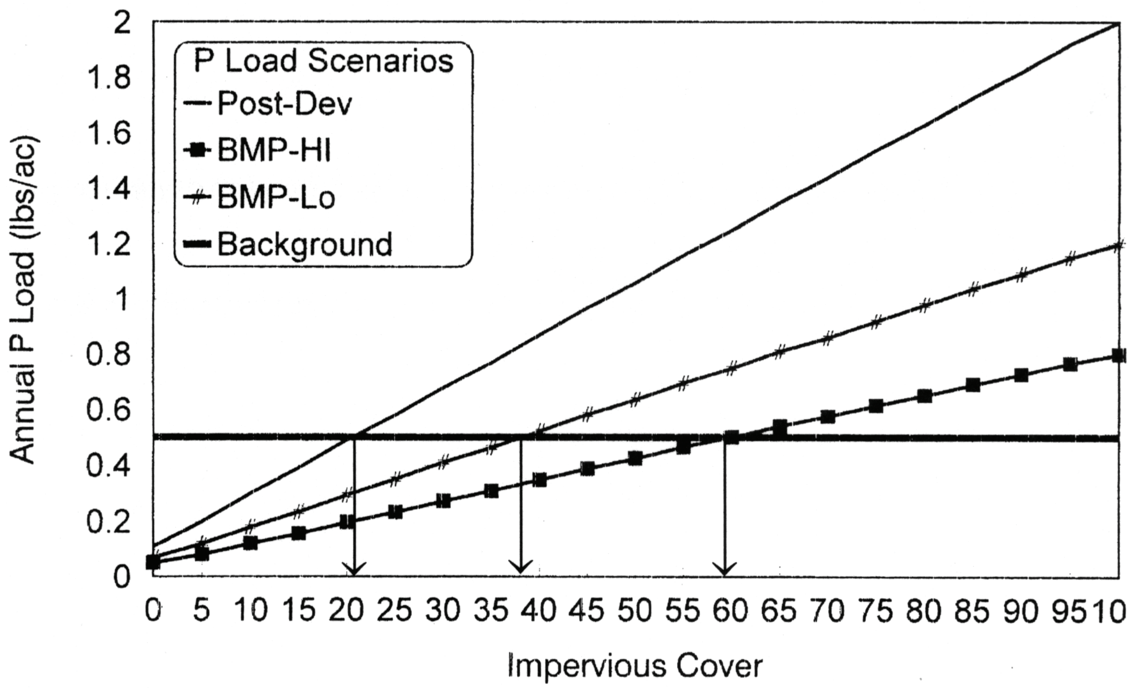
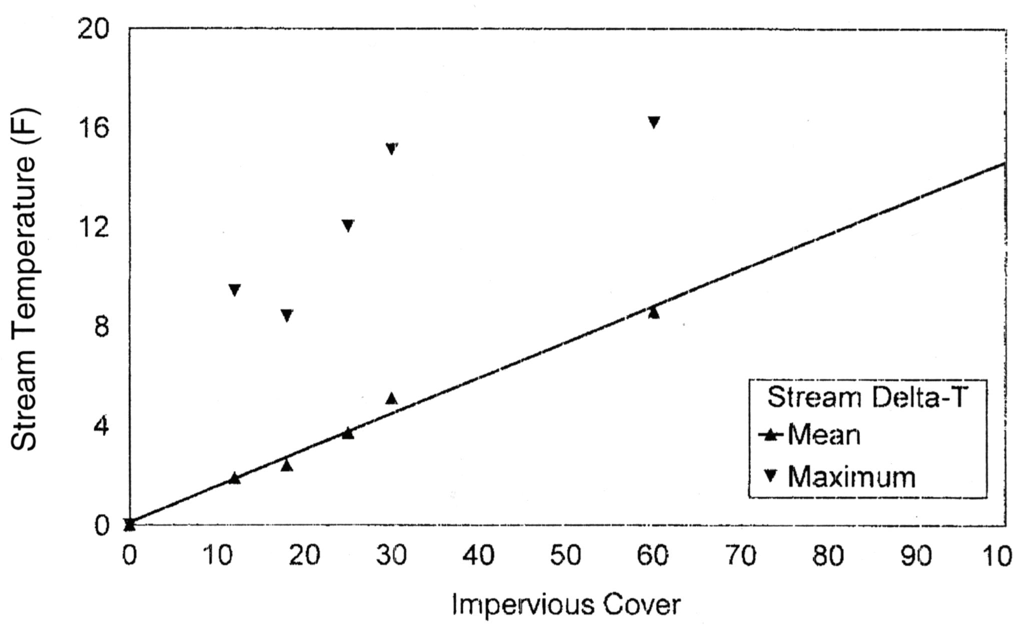


Figure 3: The Effect of Impervious Cover on Urban Phosphorus Load Under Several Scenarios, as Computed by the Simple Method



Delta-t is the difference in mean or max stream temperature from a developed stream, compared to an undisturbed stream.

Figure 4: The Effect of Impervious Cover on Stream Temperature (Galli, 1991)

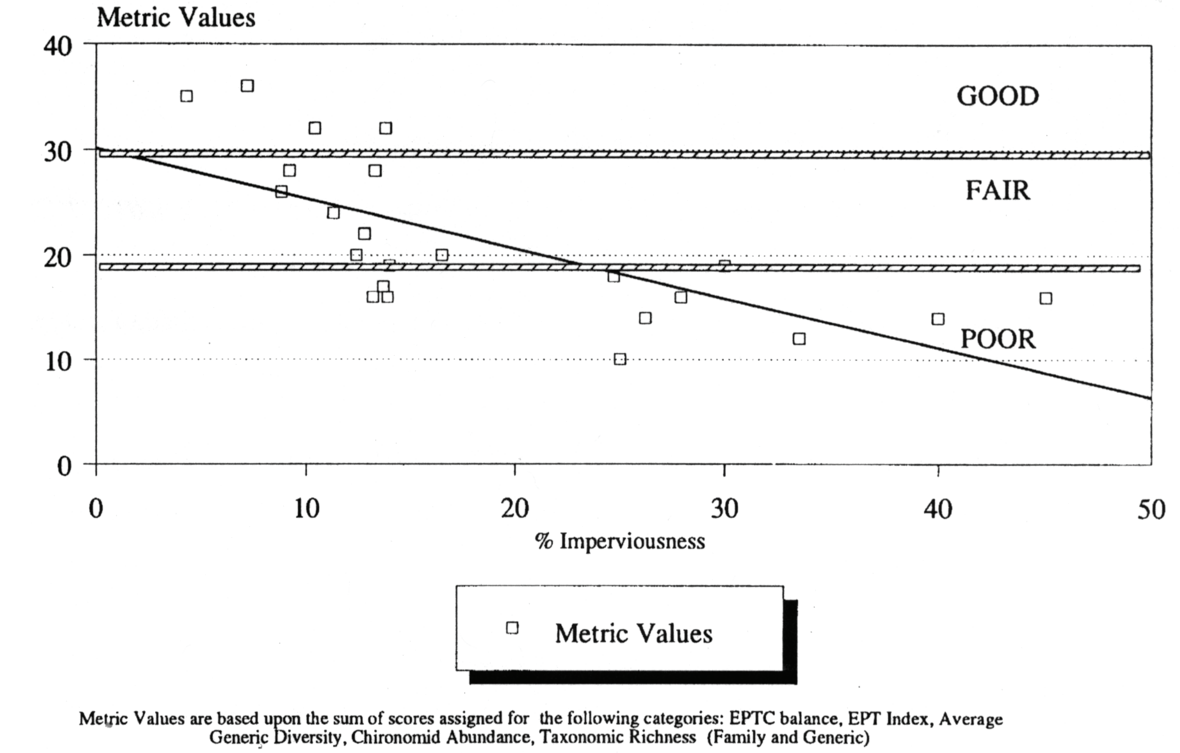


Figure 5: Impacts of Imperviousness on Macroinvertebrate Communities in the Headwater Streams of the Anacostia River (Schueler and Galli, 1992)

Aquatic Insects

The diversity, richness and composition of the aquatic insect community has frequently been used to evaluate the quality of urban streams. Not only are aquatic insects a useful environmental indicator, but they also form the base of the stream food chain in most regions of the country.

Klein (1979) was one of the first to note that macroinvertebrate diversity drops sharply in urban streams in Maryland. Diversity consistently became poor when watershed imperviousness exceeded 10 to 15%. The same basic threshold has been reported by all other research studies that have looked at macroinvertebrate diversity in urban streams (Table 2).

In each study, sensitive macroinvertebrates were replaced by ones that were more tolerant of pollution and hydrologic stress. Species such as stoneflies, mayflies, and caddisflies largely disappeared and were replaced by chironomids, tubificid worms, amphipods, and snails. Species that employ specialized feeding strategies—shredding leaf litter, grazing rock surfaces, filtering organic matter that flows by, or preying on other insects—were lost.

A typical example of the relationship between imperviousness and macroinvertebrate diversity is shown in Figure 5. The graph summarizes diversity trends for 23 sampling stations in headwater streams of the Anacostia watershed (Schueler and Galli, 1992). While good to fair diversity was noted in all headwater streams with less than 10% impervious cover, nearly all stations with 12% or more impervious cover recorded poor diversity. The same sharp drop in macroinvertebrate diversity at around 12 to 15% impervious cover was also observed in streams in the coastal plain and piedmont of Delaware (Shaver *et al.,* 1995).

Other studies have utilized other indicators to measure the impacts of urbanization on stream insect communities. For example, Jones and Clark (1987) monitored 22 stations in Northern Virginia and concluded that aquatic insect diversity composition changed markedly after watershed population density exceeded four or more individuals per acre. This population density roughly translates to half-acre or one acre lot residential use, or perhaps 10 to 15% imperviousness.

Steedman (1988) evaluated 208 Ontario stream sites, and concluded that aquatic insect diversity shifted from fair to poor at about 35% urban land use. Since "urban land" includes both pervious and impervious cover, the actual threshold in the Ontario study may well be closer to seven to 10% imperviousness (Booth and Reinelt, 1993). Steedman also reported that urban streams with intact riparian forests had higher diversity than those that did not, for the same level of urbanization.

While the exact point at which stream insect diversity shifts from fair to poor is not known with absolute precision, it is clear that few, if any, urban streams can

Table 2: Review of Key Findings of Urban Stream Studies Examining the Relationship of Urbanization to Stream Quality				
Ref.	**Year**	**Location**	**Biological Parameter**	**Key Finding**
Booth	1991	Seattle	Fish habitat/ channel stability	Channel stability and fish habitat quality declined rapidly after 10% imperv.
Galli	1994	Maryland	Brown trout	Abundance and recruitment of brown trout declines sharply at 10-15% imperv.
Benke *et al.*	1981	Atlanta	Aquatic insects	Negative relationship between number of insect species and urbanization in 21 streams
Jones and Clark	1987	Northern Virginia	Aquatic insects	Urban streams had sharply lower diversity of aquatic insects when human population density exceeded 4 persons/acre. (estimated 15-25% imperv. cover)
Limburg and Schimdt	1990	New York	Fish spawning	Resident and anadromous fish eggs and larvae declined sharply in 16 tributary streams greater than 10% imperv.
Shaver *et al.*	1994	Delaware	Aquatic insects	Insect diversity at 19 stream sites dropped sharply at 8 to 15% imperv.
Shaver *et al.*	1994	Delaware	Habitat quality	Strong relationship between insect diversity and habitat quality; majority of 53 urban streams had poor habitat
Schueler and Galli	1992	Maryland	Fish	Fish diversity declined sharply with increasing imperv., loss in diversity began at 10-12% imperv.
Schueler and Galli	1992	Maryland	Aquatic insects	Insect diversity metrics in 24 subwatersheds shifted from good to poor over 15% imperv.
Black and Veatch	1994	Maryland	Fish/insects	Fish, insect and habitat scores were all ranked as poor in 5 subwatersheds that were greater than 30% imperv.
Klein	1979	Maryland	Aquatic insects/fish	Macroinvertebrate and fish diversity declines rapidly after 10% imperv.
Luchetti and Fuersteburg	1993	Seattle	Fish	Marked shift from less tolerant coho salmon to more tolerant cutthroat trout populations noted at 10-15% imperv. at 9 sites
Steedman	1988	Ontario	Aquatic insects	Strong negative relationship between biotic integrity and increasing urban land use/ riparian condition at 209 stream sites. Degradation begins at about 10% imperv.
Pedersen and Perkins	1986	Seattle	Aquatic insects	Macroinvertebrate community shifted to chironomid, oligochaetes and amphipod species tolerant of unstable conditions.
Steward	1983	Seattle	Salmon	Marked reduction in coho salmon populations noted at 10-15% imperv. at 9 sites
Taylor	1993	Seattle	Wetland plants/ amphibians	Mean annual water fluctuation was inversely correlated to plant and amphibian density in urban wetlands. Sharp declines noted over 10% imperv.
Garie and McIntosh	1986	NewJersey	Aquatic insects	Drop in insect taxa from 13 to 4 noted in urban streams
Yoder	1991	Ohio	Aquatic insects/ fish	100% of 40 urban sites sampled had fair to very poor index of biotic integrity scores

support diverse aquatic insect communities at moderate to high levels of impervious cover (25% or more). Four different studies (Benke *et al*., 1981; Black and Veatch, 1994; Booth, 1991; Garie and McIntosh, 1986) all failed to find aquatic insect communities with good or excellent diversity in these highly urban streams.

Fish Surveys

The abundance and diversity of the fish community can also serve as an excellent environmental indicator. Surprisingly, relatively few studies have examined the influence of imperviousness on fish communities in headwater streams. The results of one study are illustrated in Figure 6. Four similar subwatersheds in the Maryland Piedmont were sampled for the number of fish species present. As the level of watershed imperviousness increased, the number of fish species collected dropped. Two sensitive species (trout and sculpin) were lost as imperviousness increased from 10 to 12%, and four more were lost when impervious cover increased to 25%. Significantly, only two species remained in the fish community at 55% imperviousness. Sensitive species, defined as those with a strong dependence on the substrate for feeding and/or spawning, showed a more precipitous decline. Klein (1979) found a similar relationship between fish diversity and watershed impervious cover in several dozen headwater streams in the Maryland Piedmont.

Salmonid fish species (trout and salmon) and anadromous fish species appear to be most negatively impacted by impervious cover. Trout have stringent temperature and habitat requirements, and seldom are present in mid-Atlantic watersheds where imperviousness exceeds 15% (Galli, 1994). Declines in trout spawning success are evident above 10% imperviousness (Galli, 1994). In the Pacific Northwest, Luchetti and Feurstenburg (1993) seldom found sensitive coho salmon in watersheds beyond 10 or 15% imperviousness. Booth and Reinelt (1993) noted that most urban stream reaches had poor quality fish habitat when imperviousness exceeded eight to 12%.

Fish species that migrate from the ocean to spawn in freshwater creeks are also very susceptible to impacts of urbanization such as fish barriers, pollution, flow changes, and other factors. For example, Limburg and Schmidt (1990) discovered that the density of anadromous fish eggs and larvae declined sharply after a 10% imperviousness threshold was surpassed in 16 subwatersheds draining into the Hudson River.

The Influence of Imperviousness on Other Urban Water Resources

Several other studies point to the strong influence of imperviousness on other important aquatic systems such as shellfish beds and wetlands.

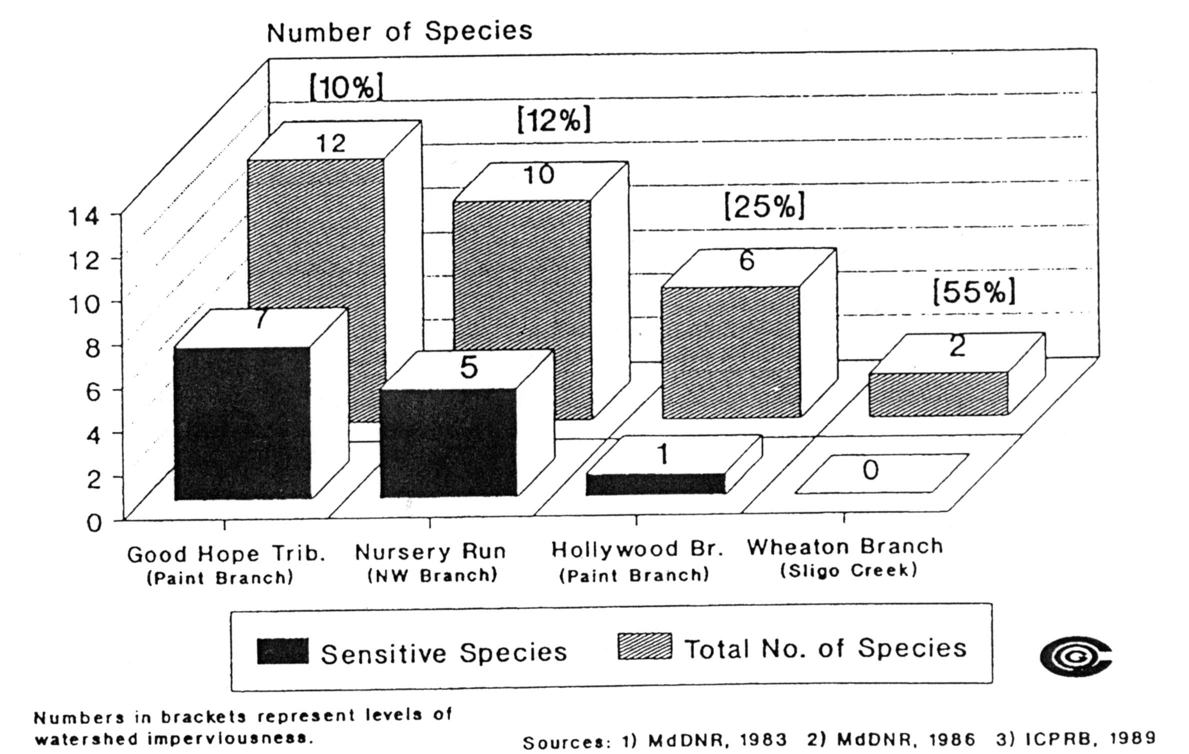


Figure 6: Fish Diversity as a Function of Watershed Imperviousness in Four Subwatersheds in the Maryland Piedmont (Schueler and Galli, 1992)

Even relatively low levels of urban development yield high levels of bacteria, derived from urban runoff or failing septic systems. These consistently high bacterial counts often result in the closure of shellfish beds in coastal waters, and it is not surprising that most closed shellfish beds are in close proximity to urban areas. Indeed, it may be difficult to prevent shellfish closure when more than one septic drain field is present per seven acres—a very low urban density (Duda and Cromartie, 1982). Although it is widely believed that urban runoff accounts for many shellfish bed closures (now that most point sources have been controlled), no systematic attempt has yet been made to relate watershed imperviousness to the extent of shellfish bed closures.

Taylor (1993) examined the effect of watershed development on 19 freshwater wetlands in King County, Washington, and concluded that the additional stormwater contributed to greater annual water level fluctuations (WLF). When the annual WLF exceeded about eight inches, the richness of both the wetland plant and amphibian community dropped sharply. This increase in WLF began to occur consistently when upstream watersheds exceeded 10 to 15% imperviousness.

Implications at the Watershed Level

The many independent lines of research reviewed here converge toward a common conclusion: that it is extremely difficult to maintain predevelopment stream quality when watershed development exceeds 10 to 15% impervious cover. What implications might this apparent threshold have for watershed planning?

Should Low Density or High Density Development be Encouraged?

At first glance, it would seem appropriate to limit watershed development to no more than 10% total impervious cover. While this approach may be wise for an individual "sensitive" watershed, it is probably not practical as a uniform standard. Only low density development would be feasible under a 10% zoning scenario, perhaps one-acre lot residential zoning, with a few widely scattered commercial clusters. At the regional scale, development would thus be spread over a much wider geographic area than it would otherwise have been. At the same time, additional impervious area (in the form of roads) would be needed to link the community together.

Paradoxically, the best way to minimize the creation of additional impervious area at the regional scale is to concentrate it in high density clusters or centers. The corresponding impervious cover in these clusters is expected to be very high (25% to 100%), making it virtually impossible to maintain predevelopment stream quality. A watershed manager must then confront the fact that to save one stream's quality it may be necessary to degrade another.

A second troubling implication of the impervious cover/stream quality relationship involves the large expanses of urban areas that have already been densely developed. Will it be possible to fully restore stream quality in watersheds with high impervious cover? Some early watershed restoration work does suggests that biological diversity in urban streams can be partially restored, but only after extensive stormwater retrofit and habitat structures are installed. For example, fish and macroinvertebrate diversity has been partially restored in one tributary of Sligo Creek, Maryland (Galli, 1994). In other urban watersheds, however, comprehensive watershed restoration may not be feasible, due to a lack of space, feasible sites, or funding.

A Proposed Scheme for Classifying Urban Stream Quality Potential

The thresholds provide a reasonable foundation for classifying the potential stream quality in a watershed based on the ultimate amount of impervious cover. One such scheme is outlined in Table 3. It divides urban streams into three management categories based on the general relationship between impervious cover and stream quality:

1. Sensitive streams (one to 10% impervious cover)
2. Impacted streams (11 to 25% impervious cover)
3. Non-supporting streams (26 to 100% impervious cover)

The resource objective and management strategies in each stream category differ to reflect the potential stream quality that can be achieved. The most protective category are "sensitive streams" in which strict zoning, site impervious restrictions, stream buffers and stormwater practices are applied to maintain predevelopment stream quality. "Impacted streams" are above the threshold and can be expected to experience some degradation after development (i.e., less stable channels and some loss of diversity). The key resource objective for these streams is to mitigate these impacts to the greatest extent possible, using effective stormwater management practices.

The last category, "non-supporting streams," recognizes that predevelopment channel stability and biodiversity cannot be fully maintained, even when stormwater practices or retrofits are fully applied. The primary resource objective shifts to protect downstream water quality by removing urban pollutants. Efforts to protect or restore biological diversity in degraded streams are not abandoned; in some priority subwatersheds, intensive stream restoration techniques

Table 3: A Possible Scheme for Classifying and Managing for Headwater Urban Streams Based on Ultimate Imperviousness

Urban Stream Classification	Sensitive (0-10% Imperv.)	Impacted (11-25% Imperv.)	Non-supporting (26-100% Imperv.)
Channel stability	Stable	Unstable	Highly Unstable
Water quality	Good	Fair	Fair-Poor
Stream biodiversity	Good-Excellent	Fair-Good	Poor
Resource objective	Protect biodiversity and channel stability	Maintain critical elements of stream quality	Minimize downstream pollutant loads
Water quality objectives	Sediment and temperature	Nutrient and metal loads	Control bacteria
Stormwater Practice Selection Factors	Secondary environmental impacts	Removal efficiency	Removal efficiency
Land Use Controls	Watershed-wide imp. cover limits (ICLs), site ICLs	Site imp. cover limits (ICLs)	Additional infill and redevelopment encouraged
Monitoring and enforcement	GIS monitoring of imp. cover, biomonitoring	Same as "Stressed"	Pollutant load modeling
Development rights	Transferred out	None	Transferred in
Riparian buffers	Widest buffer network	Average bufferwidth	Greenways

are employed to attempt to partially restore some aspects of stream quality. In other subwatersheds, however, new development (and impervious cover) is encouraged to protect other sensitive or impacted streams.

Watershed-Based Zoning

Watershed-based zoning is based on the premise that impervious cover is a superior measure for gauging the impacts of growth, compared to population density, dwelling units or other factors. The key steps in watershed-based zoning are as follows: *First*, a community undertakes a comprehensive physical, chemical and biological monitoring program to asses the current quality of its entire inventory of streams. The data are used to identify the most sensitive stream systems and to refine impervious/stream quality relationships. *Next*, existing impervious cover is measured and mapped at the subwatershed level. Projections of future impervious cover due to forecasted growth are also made at this time.

The *third* step involves designating the future stream quality for each subwatershed based on some adaptation of the urban stream classification scheme presented earlier. The existing land use master plan is then modified to ensure that future growth (and impervious cover) is consistent with the designated stream classification for each subwatershed.

The *final* step in the watershed-based zoning process involves the adoption of specific resource objectives for each stream and subwatershed. Specific policies and practices on impervious cover limits, stormwater practices, and buffers are then instituted to meet the stream resource objective, and these practices directly applied to future development projects.

Watershed-based zoning should provide managers with greater confidence that resource protection objectives can be met in future development. It also forces local governments to make hard choices about which streams will be fully protected and which will become at least partially degraded. Some environmentalists and regulators will be justifiably concerned about the streams whose quality is explicitly sacrificed under this scheme. However, the explicit stream quality decisions which are at the heart of watershed-based zoning are preferable to the uninformed and random "non-decisions" that are made every day under the present zoning system.

A Cautionary Note

While the research on impervious cover and stream quality is compelling, it is doubtful whether it can serve as the sole foundation for legally defensible zoning and regulatory actions at the current time. One key reason is that the research has not been standardized. Different investigators, for example, have used different methods to define and measure imperviousness. Second, researchers have employed a wide number of techniques to measure stream quality characteristics that are not always comparable with each other. Third, most of the studies have been confined to few ecoregions in the country. Little research has been conducted in the Northeast, Southeast, Midwest, and semi-arid Western regions. Lastly, none of the studies has yet examined the effect of widespread application of stormwater practices on impervious cover/stream quality relationships. Until studies determine how much stormwater practices can "cheat" the impervious cover/stream quality relationship, it can be argued that structural practices alone can compensate for imperviousness effects.

On the positive side, it may be possible for a community to define the impervious cover/stream quality relationship in a short time and at relatively low cost. A suggested protocol for conducting a watershed monitoring study is presented in Table 4. The protocol emphasizes comparative sampling of a large population of urban subwatersheds of different increments of imperviousness (perhaps 20 to 50).

A rapid sampling program collects consistent data on hydrologic, morphologic, water quality, habitat and biodiversity variables within each subwatershed. For comparison purposes, series of undeveloped and undisturbed reference streams are also monitored. The sampling data are then statistically and graphically analyzed to determine the presence of imperviousness/stream quality relationships.

The protocol can be readily adapted to examine how stormwater practices can shift the stream quality/imperviousness relationship. This is done by adjusting the sampling protocol to select two groups of study subwatersheds: those that are effectively served by stormwater practices and those that are not.

Table 4: Proposed Protocol for Defining Functional Relationships Between Watershed Imperviousness and Stream Quality

- General study design
  A systematic evaluation of stream quality for a population of 20 to 50 small subwatersheds that have different levels of watershed imperviousness. Selected field measurements are collected to represent key hydrological, morphological, water quality, habitat and biodiversity variables within each defined subwatershed. The population of subwatershed data is then statistically analyzed to define functional relationships between stream quality and imperviousness.
- Defining reference streams
  Up to 5 non-urban streams in same geo-hydrological region, preferably fully forested, or at least full riparian forest coverage along same length. Free of confounding NPS sources, imperviousness less than 5%, natural channel and good habitat structure.
- Basic Subwatershed Variables
  Watershed area, standard definition and method to calculate imperviousness, presence/absence of stormwater practices.
- Selecting subwatersheds
  Drainage areas from 100 to 500 acres, known level of imperviousness and age, free of confounding sources (active construction, mining, agriculture, or point sources). Select three random non-overlapping reaches (100 feet) for summer and winter sampling of selected variables in each of five key variables groups:

  1. Hydrology variables: summer dry weather flow, wetted perimeter, cross-sectional area of stream, peak annual storm flow (if gaged).
  2. Channel morphology variables: channel alteration, height, angle and extent of bank erosion, substrate embeddedness, sediment deposition, substrate quality.
  3. Water quality variables: summer water temperature, turbidity, total dissolved solids, substrate fouling index, EP toxicity test, wet weather bacteria, wet weather hydrocarbon.
  4. Habitat Variables: pool- riffle ratio, pool frequency, depth and substrate, habitat complexity, instream cover, riffle substrate quality, riparian vegetative cover, riffle embeddeness
  5. Ecological Variables: fish diversity, macroinvertebrate diversity, index of biological integrity, EPA Rapid Bioasessment Protocol, fish barriers, leaf pack processing rate.

Conclusion

Research has revealed that imperviousness is a powerful and important indicator of future stream quality and that significant degradation occurs at relatively low levels of development. The strong relationship between imperviousness and stream quality presents a serious challenge for urban watershed managers. It underscores the difficulty in maintaining urban stream quality in the face of development.

At the same time, imperviousness represents a common currency that can be measured and managed by planners, engineers and landscape architects alike. It links activities of the individual development site with its cumulative impact at the watershed scale. With further research, impervious cover can serve as an important foundation for more effective land use planning decisions.

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Exhibit L

SKYPARK AT SANTA'S VILLAGE

FINAL ENVIRONMENTAL IMPACT REPORT

SCH No. 2015091001

Lead Agency

County of San Bernardino
San Bernardino County Land Use and Services Department
Planning Division
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May 2017

Comment Letter B4 – Sierra Club, San Gorgonio Chapter

SIERRA CLUB
FOUNDED 1892

San Bernardino Mountains Group
San Gorgonio Chapter

P.O. Box 651
Blue Jay, CA 92317

July 22, 2016

Kevin White, Senior Planner
Planning Division County of San Bernardino Land Use Services
385 N. Arrowhead Ave., First Floor
San Bernardino, CA 92415-0187
E-Mail: kwhite@lus.sbcounty.gov

Re: **Project No. P201500051/CF; Draft EIR Availability; Skypark at Santa's Village**

Dear Mr. White,

The San Bernardino Mountains Group of the San Gorgonio Chapter of the Sierra Club (Mtns Group) is based in the western region of the San Bernardino National Forest (SBNF). Our local 200 members are proud to identify with Sierra Club, our nation's largest and most effective environmental grassroots organization. We are familiar with the area of the proposed Skypark project and appreciate this opportunity to comment on the released Draft EIR for Skypark at Santa's Village. B4.1

As we expressed in our letter responding to the Notice of Preparation, we hereby repeat several of our concerns about the potential impacts of the project to the value and vitality of the immediate and surrounding community and natural ecosystems. The Draft EIR appears to have made several omissions, errors in evaluations, and erroneously assumed that acknowledgement and assurances for future mitigation definitions and their particulars adequately provide the public disclosure requirements mandated by the California Environmental Quality Act (or CEQA).

Also, there was some confusion in your notice of availability letter (which is notably missing from the County website listing the history of public notices for the Skypark project (see: http://cms.sbcounty.gov/lus/Planning/Environmental/Mountain.aspx screen shot pasted at end of this letter). The letter we received indicated comments were due on Monday, July 22. July 22, 2016 is not a Monday. We also hope that the email provided for Kevin White is accurate, as it appears to have changed since last year. (Kwhite@, from Kevin.white@). Without an online copy of the availability notice, it is not possible for the average citizen to determine a due date for comments, or even the current contact information (new since the Notice of Preparation) for Mr. White. B4.2

In no particular order, we make the following comments:

Page 1 of 9 **Sierra Club San Bernardino Mountains Group Comments on Skypark DEIR**

The project analysis does not appear to accurately mirror the project description. Discrepancies between the purported and intended uses and facilities of the project and the environmental analysis assumptions of various elements are frequently in conflict, or simply missing.

Examples are:

1) The project description includes winter sports such as sledding, an ice rink, etc, yet the DEIR does not evaluate the impacts or describe the location and/or facilities of said recreation.
2) Literature for the project, and the intended uses for the project as described by the CUP applicant include special events for the local community. The capacity and character of those local events are not described or evaluated in the DEIR. In particular, the only possible reference to an analysis of local events found, was in the traffic impact analysis where it was assumed that there would be a single special event per year, that it would only occur at night, and that it would only generate about 50 vehicle trips. This conflicts with one of the intended purposes of the project identified in Section 8 (Alternatives): "provide a venue for local community events" In the past, special events held at the Skypark location (such as concerts in the meadow) have attracted a great deal more attendance than is being analyzed. True traffic impacts as well as other venue considerations need to be disclosed in a revised DEIR

3) Campfire pits are identified in the DEIR text, but are not located on the project description map. The extension of gas lines across State Hwy 18 to the fire pits is referred to in the DEIR, but not located or evaluated for safety. There has been conflicting information regarding the consideration/inclusion of Recreational Vehicles in the southern camping area. Several references to RV's can be found in the document, but the environmental effects and required mitigations for the support of RV's (lights, noise, generators and their potential emissions, etc) B4.3
4) Expected attendees, seem to be divided into two or three major groupings: Santa's Village park revelers, outdoorsy folk - mountain bike enthusiasts and the like, and campers. However, estimates about the numbers of those groups were either missing or very hard to find. This is an important element in determining the expected project impacts because the numbers determine the likely amount and characteristics of activity in the separate areas of Skypark. As an example, how consistent during the day, and how frequent bikes will be traversing the majority of the park. If constant or even very frequent, the impacts to habitat is high, especially to nesting activity. The habitat assessment identifies Feb to Aug as a no-activity period for at least the spotted owl, but the mitigation/condition requirements for that are not discernable in the DEIR.
5) A zipline facility is planned to be added to the current set of existing structures according to the DEIR. However, it was not at all clear where that will occur, and how it will be operated during habitat-sensitive seasons.

It is unfortunate for the public that the CUP project application, with its own description, and currently proposed conditions were not available to the public in this review to assist in evaluating the adequacy of the Draft EIR. An accurate understanding of the details of the project is inevitably critical to the full appreciation of the project's potential impacts.

The EIR should have analyzed a down-sized alternative project. The project goals could easily be satisfied with a smaller footprint/impact project. The CEQA Alternatives section is B4.4

inadequate. Are the bicycle trails needed? Are the impacts of the project without the trails, environmentally superior? B4.4 cont'd

It is unclear in the project description what the policy for animals will be at the park. During winter play, and perhaps with the camping attendees as well as the bicycle enthusiasts, welcoming pets to the park (especially dogs) will be an attractive feature of the park. Yet the presence of pets and animals in habitat areas brings its own set of challenges and impacts. The DEIR appears to be silent with respect to its policies towards animals at Skypark and its various activities. Clarity is needed, before the public or the County can act in an informed way. B4.5

One of the fundamental concerns of the Mountains Group is the viability of the very important north-south wildlife corridor that the proposed project sits squarely within. Although the DEIR acknowledges the impact, it unfairly and without reasonable justification, dismisses the impact as minimal since the identified corridor extends beyond the project location. What is missed in the DEIR analysis, is the critical importance of the actual site. The presence of the current and long-standing watercourse, pond, and wetlands area of the Skypark site, especially when considered with the natural path up the mountain, in the ravine and cover immediately below the proposed camping area, and the corridor destination of proceeding north within the Hook Creek riparian area, the most favored, and historically frequent corridor path is through the proposed park property. Water and green vegetation is key to safe wildlife movement , and yet the meadows, stream and pond of Skypark, leading directly to Hook Creek, Deep Creek and beyond, is the primary, if not the only wet path in the apex of the identified corridor. To dismiss this as insignificant is inappropriate. B4.6

Related to this, and not mentioned in the DEIR, is the upgraded fencing that now lines the Skypark property along Highway 18 on the north side. Fencing this corridor area with this new, imposing, and restricting structure has created another disturbing diminution of the corridor's viability. In evaluating the impacts of the proposed project, the DEIR needs to also consider the impacts of the fencing in of the project parcel, beyond just the impacts of the major activity near the camp, parking lots and watercourse. We ask the County to not only require an analysis of the impacts of the fence, but also ask for a review of the permitting status of the fence. There is a concern that assumptions were made about the legality of its installation. B4.7

We refer the County and project planner to a helpful Caltrans document about understanding and effecting wildlife crossings: It is called Wildlife Crossings Guidance Manual, produced by Caltrans. B4.8

The Draft EIR appears to use Skypark's conservation plans and coordination with NRCS for the creation/restoration of the Meadow, stream and pond areas as the mitigation and management for several environmental factors. For example, the runoff impacts from several hundred cars and the recreating public on the headwaters to Hook Creek specifically and the quality of habitat in the lowland area just north of the parking lot in general. However, there is no specificity to any of it, simply a general statement of intent and of the issues. Statements like the 3 holding ponds of the planned reconstituted stream "will eliminate" any pollution concerns. This is not adequate for CEQA'S .purposes. B4.9

In that same vein of unacceptable "assurances" without adequate supporting detail, we observe that we could not find any hydrological study for the project area and the surrounding watershed that feeds into the project area, stream, pond , Hook Creek and ultimately Deep Creek, a wild B4.10

Page 3 of 9 **Sierra Club San Bernardino Mountains Group Comments on Skypark DEIR** and scenic watercourse. In order to provide assurances to the public that the runoff, pollution, detritus, and flows can be managed by the proposed project infrastructure, a hydrologic study should be available to establish stormwater flows for the area, for both average, and 10-, 50- and likely 100- year events. What is often clearly articulated in the DEIR is a recitation of the challenges and requirements for environmental mitigations. Bald statements without clear numbers and supporting documentation that proposed solutions will be adequate is not adequate for CEQA requirements. B4.10 cont'd

Here is the only Hydrological evaluation we can find in the DEIR:

> There are no known active or inactive stream gages on Hooks Creek (USGS, 2015). Accordingly, the surface flow of the creek is unknown. Area-weighted average annual precipitation in the subunit is 36.5 inches/year, which is equivalent to approximately 3,585 acre-ft/yr of annual precipitation over the entire 1,195-acre subunit (Geoscience, 2005).
> Average annual surface runoff in Hook's Creek Subunit has been estimated by Geoscience (2005) to be approximately 960 acre-ft/yr. It is assumed for this analysis that this is approximately equivalent to the long-term average annual flow in Hooks Creek.

B4.11

This is inadequate information to determine if the planned pond and stream contrivances are adequate to handle a storm event. As is commonly joked about, one can drown in a lake with an average depth of only 1-inch. Similarly, citing only average precipitation in the area is not sufficient to describe possibilities. It is not rare to see 10 or more inches of precipitation fall in a 24-hour period in our mountains. If the pond is typically being maintained close to full, what will happen in such a storm?

We have several concerns about the adequacy and accuracy of the traffic study and its conclusions.

First, although the study identified peak summer and Christmas weekends as the peak trip flows to be analyzed, the traffic counts were taken on a non-holiday weekend in Dec, which is definitely not a peak traffic season currently in the area. Though Skypark may anticipate December and Xmas attendance peaks, impacts on similar summer peak days will occur simultaneous to the area's summer peak traffic. Traffic counts need to reflect realistic peak situations. Compared to previous studies done for the Church of the Woods project, as well as for the 2007 San Bernardino General Plan, recognize higher counts than are being used for Skypark's study. This should be corrected. National Weather Service records show that on Dec 13 (one of the days traffic counts were taken) had a high of 45/low of 32 and mild precipitation. This would not be a good example of a peak traffic situation. As I understand the traffic study scoping, the study was to assume good weather, which this was not. In contrast to that, as most mountain residents know, one of the likeliest negative effects on traffic will be on inclement weather days. Especially if sledding and/or other winter recreational activities are being planned for the park. Snow on the roads in our mountains create very dangerous situations. Traffic snarls due to inexperienced drivers on ice and in fog, is compounded by unsafe recreation along the highway. The Draft EIR should examine the potential impacts of increased traffic during our very consistent, very frequent and very reliable "bad days" on the mountain. If Skypark expects to bring 2500 new people onto Highway 18 during the Christmas and winter holiday weekends, traffic and safety impacts need to be carefully revisited and mitigations considered. This should include possible closure policies for the project during inclement weather. B4.12

For an example of the kind of snarls we endure on our highways during true peak flow periods, see the screen print below from Google satellite maps of Highway 330 trying to access our mountain resorts. As it happens, this particular view isn't even during bad weather, but is instead just a normal busy weekend. The Traffic study for Skypark is inadequately analyzing our circulation characteristics. B4.12 cont'd

Furthermore, the Skypark traffic study did not evaluate the cumulative impacts of another large project in the area that the County has been aware of for many years, is still an active project, and has already acknowledged future significant traffic impacts on the roads and intersections evaluated for the Skypark DEIR. To fully disclose all reasonably foreseeable impacts of the Skypark project, the DEIR should reevaluate the project's impacts in concert with the anticipated and already well-established plans and mitigation requirements of the Church of the Woods project (located at the intersection of Daley Canyon and highway 18 (one of the evaluated locations in the Skypark DEIR).

Peak traffic and peak times for the Church of the Woods project (supporting event attendance projections equivalent and sometimes more than the planned attendance of the Skypark facility) will coincide with the projections for Skypark's vehicle traffic. This needs to be considered as the combination of simultaneous peak trips from both projects will greatly reduce local circulation flow, and may require signalization requirements top support Skypark's trip contributions at several intersections. As background, the Church of the Woods Final EIR traffic mitigation requirements triggered several signalization requirements. By reference here, please include the currently still posted (as of July 21, 2017) environmental documents for the Church of the Woods project located on the San Bernardino County Land Use Services website at http://cms.sbcounty.gov/lus/Planning/Environmental/Mountain.aspx

To make this clear, here is an excerpt describing the projected trip generation of the church's project: B4.13

> The Sunday peak hour trip generation was calculated based on estimated church attendance. The church will have two Sunday services: 8:30 to 10:00 a.m. and 11:00 a.m. to 12:30 p.m. There will be one hour between services, during which time the attendees from the first service will depart and the attendees of the second service will arrive. Based on current attendance and future projections, it is expected that each service will have 500 attendees by 2009 and 1,200 attendees by 2013. Attendees will arrive and depart via automobiles with an average occupancy of three persons per vehicle. Based on these assumptions, the church is projected to generate 334 trips during the Sunday peak hour in 2009 and 800 trips during the Sunday peak hour in 2013 and 2030.

While it is understood that only a portion of those trips will be generate over highway 18 past the proposed Skypark location, there will certainly be enough to trigger the CEQA requirement for further analysis of the cumulative effects, generating possible new mitigations for future traffic controls. It should also be obvious from the two project descriptions that they share peak traffic hours which will certainly exacerbate the situation on Highway 18. More importantly, when local events are taken into consideration, (planned for both projects according to their respective project goals), the assumed distribution of vehicle trips will be markedly different than the apportionment used in the current Skypark analysis. The Skypark study assumes only 15% or less of the average trips to the park will be from the local communities (north of Highway 18). For popular local events, that percentage would change dramatically, and the trip volume effects on secondary intersections at and north of Highway 18 will be significant, indeed.

The traffic impact evaluation for Skypark is surprisingly bad. It needs to be redone and the Draft EIR revised and recirculated. B4.14

Regarding traffic, SANBAG's (San Bernardino Association of Governments), acting as the responsible party for our region's Congestion Management Program, has identified and highlights the intersection at Hwys 173/18 as a problem in their Mountain Area Transportation Study. Note immediately below, from their MATS website tool, MATS clearly identifies this intersection will be problematic with increased traffic flow. With the addition of the majority of Skypark trips relying on this intersection to access the project (all attendees not coming from Running Springs or up from Highway 330 – a longer circuitous route from the Valley - and combined with the significant additions of the pending Church of the Woods project, it is undeniable that Skypark's Draft EIR's conclusion that further analysis on this intersect is unneeded, is simply and egregiously wrong.

MATS Project Sites: B4.15

Description SR-173 at SR-18

Notes	Poor traffic control, and confusing intersection. Will become more of an issue with additional development
Type	Operational

As layman in the traffic analysis area, we hope that the County will provide its expertise in explaining if a CMP should be required for this project. Unable to find an articulation of the County's policy that expressly defines the requirement for doing a CMP study, it may still be the case that the TIA may not be sufficient based on the number of anticipated trips on highway 18. As the justification for not doing a CMP for Skypark was no CMP monitored intersection was identified, and the justification for the Church of the Woods not doing a CMP was not reaching a trip threshold, we are admittedly confused, and respectfully request clarification of the requirement and its triggering conditions. B4.16

Regarding hazards, we see the following statement in the EIR:

> **Impact 4.8-8 Implementation of the Project would not expose people or structures to a significant risk of loss, injury or death involving wildland fires with Mitigation Incorporated.**
>
> Based off the California Department of Forestry and Fire Protection (Cal Fire), the Project is not located within a Very High Hazard Severity Zone. The list of areas in San Bernardino County with a Very High Hazard Severity Zone does not include Lake Arrowhead or the Skyforest community. B4.17

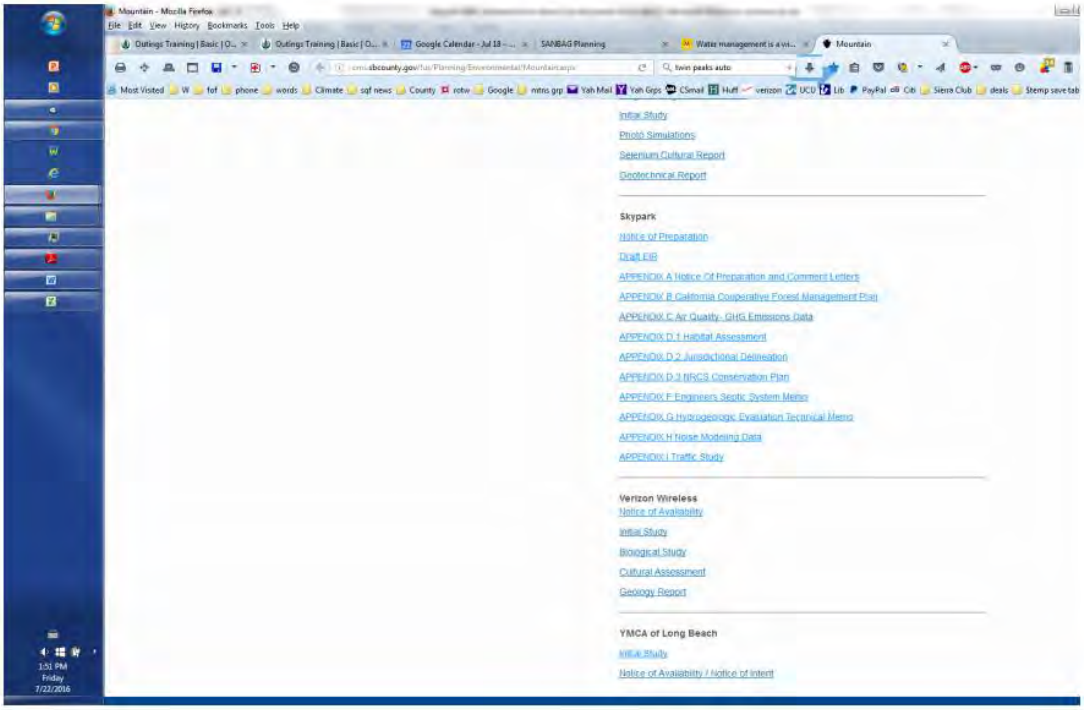
THIS IS NOT TRUE maps of currently defined Very High Hazard Serverity Zones can be found here: http://www.fire.ca.gov/fire_prevention/fhsz_maps_sanbernardinosw

Maps clearly show the project area is fully within a VHFHSZ. Fire Hazard exposure mandates extreme caution with the facilities proposed, and the development of a generic Emergency Evacuation Plan for the purposes of this DEIR is inadequate. Furthermore, once again, the DEIR simply promises the creation of an adequate emergency and evacuation plan, rather than provide it for public review. A full description of the plan should be made available for comments prior to approval. B4.17 cont'd

Thank you again for your attention,

Steven Farrell
Conservation Chair
San Bernardino Mountains Group – Sierra Club

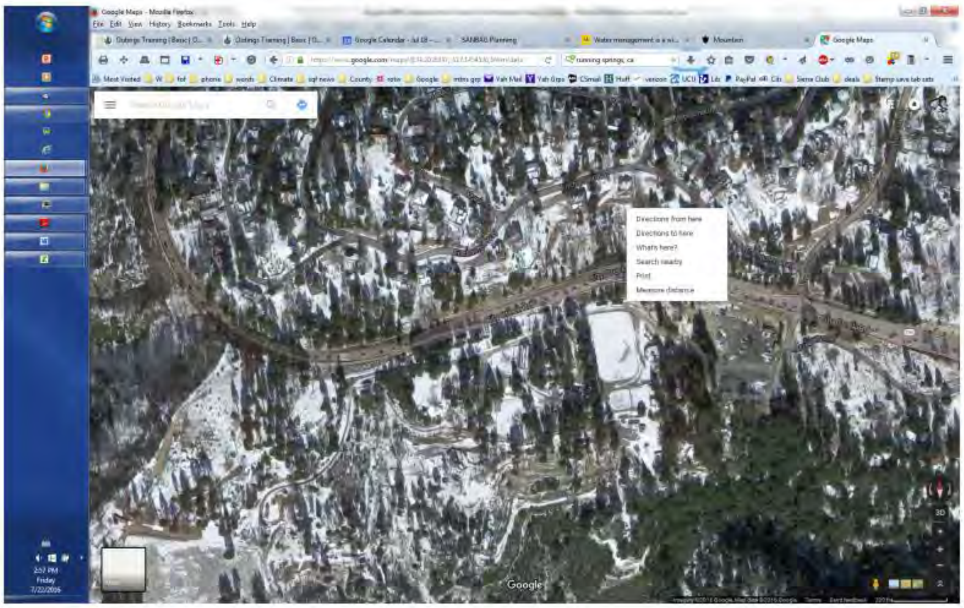
No online notice of availability:



Page **8** of **9** **Sierra Club San Bernardino Mountains Group Comments on Skypark DEIR**

Current (July 22, 2016) Google map view of highway 330 at Live Oak.

Although this is a snapshot of only a small section of the road, traffic has jammed several miles below this site near Running Springs. This is a very common event during holiday peak travel times. This is exactly when Skypark is forecasting its own peak attendance with (from its TIA study), approximately 40% of vehicle trips to Skypark passing this intersection at Live Oak. The traffic analysis inadequately evaluates peak flows, and therefore the County cannot appropriately justify proper mitigations.



Response B4
Steven Farrell, Conservation Chair

B4.1: The DEIR does not contain omissions or errors or make erroneously assumptions in the impact analysis as outlined in further detail in Responses to Comment B4.2 through B4.17 below.

B4.2: The following is the information that was provided in the Notice of Availability related to the public comment period:

"Public Comment Period: The DEIR and its technical studies are available for the CEQA required 45-day public review and comment period from June 7, 2016 through July 22, 2016. Written comments on the Draft EIR and technical studies must be received no later than 4:30 pm on Monday July 22, 2016."

The comment correctly identifies an error in the Notice of Availability that was sent out to agencies, organizations and the public at the release of the public review Draft EIR on June 7, 2016. The error is that the notice indicated that the comments on the DEIR were due on "Monday" July 22, however, July 22 in the year 2016 falls on a Friday. However, the notice clearly states that the CEQA required 45-day public review and comment period is from June 7, 2016 through July 22, 2016. If anyone was confused about the deadline for comments to be submitted to the County for this project, contact information for Kevin White the project planner, was also provided in the notice including a telephone number. Anyone from the public could have called, written an email or letter, or gone to the County building to get clarification related to the deadline for comments. All contact information for Kevin White, the project planner, was correctly provided in the Notice of Availability. The email that was provided in the notice for the County Planner Kevin White "kwhite@lusd.sbcounty.gov" is correct and was correct at the time the Notice of Availability was issued.

B4.3: The analysis contained in the DEIR in Section 4.0-4.17 Environmental Analysis, Section 5.1-5.5 Other CEQA Required Topics, Section 6.0 Effects Found Not to be Significant, Section 7.0 Growth Inducing Impacts, and Section 8.0 Alternatives were all based on the detailed project description contained in Section 3.0.

Section 3.0 of the Project Description does identify snow play activities under the Amusement Park Zone description on page 3.0-28 and under the Santa's Village/ Winter Attractions description on page 3.0-32. The general location of the Amusement Park Zone is provided here. However, the location of the Amusement Park Zone was added to Exhibit 3.0-3, *SkyPark at Santa's Village Site Plan,* to provide further clarification. The proposed activities in the Amusement Park Zone and this location was analyzed as part of the proposed Project throughout the DEIR. The project description in the DEIR also included a description of the campground Site (page 3.0-33) and the camp fire rings. The exact location of the camp fire rings is not known at this time and was not included on the site plan. Campfire safety and the potential of wildfires was analyzed in the DEIR in Section 4.8 Hazards and Hazardous Materials (page 4.8-19-4.8-21).

The proposed project in the Conditional Use Permit (CUP) application are superseded by the project description in the DEIR. The project description in the DEIR was refined after the CUP application was submitted to the County. The analysis in the DEIR is based on the project description of the DEIR which is the current proposed project. Although special events, such as concerts in the meadow, were held in the past they are not currently proposed. The DEIR project description describes the current proposed project and activities.

Lighting from the campground where the RV's would be located is analyzed in Section 4.1 Aesthetics, Light and Glare, the vehicle exhaust emissions from RV's is accounted for in the trips to and from SkyPark identified in the Traffic Impact Analysis (Appendix I) and the air quality and greenhouse gas emissions modeling (Appendix C). An evaluation of the noise generated by the project, including the campground, is included in Section 4.12 Noise of the DEIR.

Section 3.0 Project Description of the DEIR described the total number of visitors expected in the winter and summer seasons. Per page 3.0-33,

"Peak season for the proposed project is anticipated to be November and December (approximately 2,000 visitors per day). Low season is anticipated to be during spring and early fall. Summer is anticipated to have an average of 1,000 visitors per day. Operating hours are proposed to be 8AM to 10PM. The project is proposed to be fully operational year round, with no planned closures."

The potential impacts to sensitive wildlife species is analyzed in the DEIR, Section 4.4 Biological Resources. This section also includes 25 mitigation measures to reduce potential impacts to biological resources.

The proposed zipline is described in Section 3.0, Project Description, page 3.0-31. However, the location of the ziplines were added to Exhibit 3.0-3, *SkyPark at Santa's Village Site Plan*, to provide further clarification.

B4.4: Refer to Response to Comment B1.3 above.

B4.5: Dogs may be allowed at SkyPark. However, if allowed, they will be required to be on a leash at all times in accordance with the San Bernardino County leash law.

B4.6: The analysis contained in the DEIR identifies the importance of wildlife corridors and indicates that the project is located entirely within a wildlife corridor designated in the San Bernardino County General Plan Open Space Element. As outlined in the DEIR, Section 4.4 Biological Resources, page 4.4-21,

"Habitat linkages provide links between larger undeveloped habitat areas that are separated by development. Wildlife corridors are similar to linkages, but provide specific opportunities for animals to disperse or migrate between areas. A corridor can be defined as a linear landscape feature of sufficient width to allow animal movement between two comparatively undisturbed habitat fragments. Adequate cover is essential for a corridor to function as a wildlife movement area. It is possible for a habitat corridor to be adequate for one species but inadequate for others. Wildlife corridors are significant features for dispersal, seasonal migration, breeding, and foraging. Additionally, open space can provide a buffer against both human disturbance and natural fluctuations in resources.

The project site is surrounded by natural plant communities and forest and is located entirely within a wildlife movement corridor, as designated by the San Bernardino County General Plan Open Space Element (Exhibit 8, *Wildlife Corridors* in the HA). The site is located within an area designated simply as "Dispersion Corridor," which provides movement opportunities primarily between the Deep Creek and City Creek designated corridors. The dispersion corridor essentially allows wildlife an area to utilize for traversing the San Bernardino Mountains from the north (Deep Creek) end to the south (City Creek), and vice versa."

The conclusion in the DEIR that the project will not interfere substantially with wildlife movement was based on the fact that the proposed improvements will largely be confined to existing developed/disturbed areas and the undeveloped forest surrounding the existing buildings and infrastructure has the potential to support the movement of muledeer, bobcat, coyote, and black bear through and around the site.

The proposed improvements do not include large structures or perimeter fencing that would impede wildlife movement across the site. The proposed location of the campground is open and largely devoid of vegetative cover due to past fires, use as staging area, and existing paved parking lot. As outlined above, adequate cover is essential for a corridor to function as a wildlife movement area. Thus, the existing camping site area does not provide adequate cover for a wildlife cover. Wildlife moving along the corridor are anticipated to move in a north-south direction on either the east or west side of the open campground area. Therefore, construction of the campground and use of the campground is not expected to interfere substantially with wildlife movement.

As outlined the DEIR, Section 4.4 Biological Resources, page 4.4-45,

"The meadow rehabilitation project will realign, expand, and restore the upstream portions of Hooks Creek and will include removal of the wood chips and other debris that were left behind from previous activities. The meadow rehabilitation project will also entail constructing a lined waterway along the length of the meadow, periodically split by new water/sediment control basins, to connect to an onsite pond. Exotic vegetation and large obstructions will be removed throughout the meadow, and new hedgerows will be planted along its perimeter. Wildlife structures including nest boxes, downed wood, and rock piles will be strategically located at different locations along or near to the new waterway."

Restoration of Hencks meadow includes enhancements that will also improve its habitat function and value for wildlife movement. As outlined in Mitigation Measure MM BIO-6, trails signs and physical barriers shall be strategically placed along the trail, under direction of a qualified biologist, to prevent guests from wandering outside of the trail boundaries. The qualified biologist will ensure that use of physical barriers will not prohibit wildlife movement. Hooks Creek north of and downstream of the existing pond, will not be impacted and will be preserved within the site. Therefore, within the Project site the existing wildlife corridor along Hencks Meadow, the pond, and Hooks Creek will be preserved and enhanced and will continue to provide for unobstructed wildlife movement.

B4.7: The Project site in the past has had more fencing. The previous owners had animals on the site and had perimeter fencing on the site to contain the animals. The current owner has removed this fencing, an estimated 3 miles of it. Currently the site contains no more than a total of approximately 500 linear feet of fencing at two different locations. Two segments of approximately 100 feet of fencing occurs at the driveway of Santa's Village on SR-18 and on the west side of the property along SR-18 where there is a dirt road access for CLAWA easement. These segments of fencing are to control unauthorized access to the site by people. Because the existing fencing is only in short discontinuous segments it is not an impediment to wildlife movement.

B4.8: The Caltrans Wildlife Crossings Guidance Manual is available online at https://roadecology.ucdavis.edu/files/content/projects/CA_Wildlife%20Crossings%20Guidance_Manual.pdf

As outlined in the Manual, Section 1.1.2 Who Should Use the Manual, page 2,

"The intended primary audience for this manual is Caltrans biologists and other technical staff at the agency. It may also be useful to other transportation experts involved in planning, program management, or maintenance that need to know how roads may affect wildlife and ecological systems in California. "… "Transportation planning decisions have both a regulatory and an ecological context, and the manual seeks to integrate both to provide guidance, in the form of a process illustrated schematically in Figure 1, to those with responsibilities for identifying and mitigating wildlife crossing, listed species, habitat connectivity, and public safety conflicts."

The manual is intended to assist Caltrans and any other agencies planning for new or expanded transportation facilities and avoiding, minimizing, and/or mitigating impacts of those facilities on existing wildlife corridors. The project will construct a new signalized intersection along SR-18 at the modified driveways/entrance in order to provide for safe entrance and exit to the park and campground for both visitors and other drivers using SR-18. The project does not include construction of a new roadway or expanded roadway. Although the Manual provides helpful information, guidance and tools related to crossings of wildlife corridors, it is not directly applicable to the proposed Project.

B4.9: As outlined in Response to Comment A2.2 (from the Lahontan Regional Water Control Board), for the onsite restoration of Hencks Meadow and Hooks Creek the USDA Natural Resources Conservation Service did prepare Drawings and Specifications for the Lined Waterways or Outlet and Water & Sediment Control Basins which include Detail Plans for the Water & Sediment Control Basins and Lined Waterways. Both of these documents have been added to the EIR Appendices, in Appendix K, Drawings and Specifications, in response to comments on the DEIR to allow for public and agency review of these documents. The Drawings and Specifications include Practice Standards, Job Classification, Design Calculations, Environmental Assessment, Utility Check Sheet, Engineer's Cost Estimate, Operation & Maintenance Requirements, Practice Specifications, Practice Requirements, and Construction Drawings. The construction drawings or detail plans include the overall plan view, plan view and profile views of the three sediment basins (south, middle, and north), and section views of the rock lined waterways (south, middle and north).

The existing hydrology of the site is outlined in the DEIR, Section 4.9 Hydrology and Water Quality, page 4.9-1 to 4.9-2,

"The entire Santa's Village attraction area between attractions/buildings was paved with asphalt. Stormwater runoff from the developed park area and surrounding forested area to the park area and parking lot are conveyed via sheet flow downslope to the park area and into v-ditches and corrugated pipes to the northern portion of the developed site and end of paved parking lot to the disturbed grassy meadow. Stormwater runoff is conveyed in a northern direction through the disturbed meadow in a small incised channel to a manmade pond."…

"Stormwater runoff originating north of SR-18 sheet flows for approximately 700 feet across the existing paved parking lot of Santa's village before flowing into the grassland meadow. Hooks Creek extends through Hencks Meadow for approximately 530 feet before it continues for approximately 420 feet through the area previously disturbed when it was used as a storage yard and staging area for the bark beetle infested lumber. Hencks Meadow is a natural, narrow meadow located northeast of the existing parking lot north of SR-18, along the property's eastern boundary. Per a 1953 USGS topographic map, Hooks Creek was mapped as intermittent in the Hencks Meadow area and perennial downstream of Hencks Meadow. After the disturbed area, Hooks Creek extends through a southern willow scrub plant community for approximately 1,200 feet before exiting the property."

Currently stormwater runoff from the Santa's Village attraction and the existing parking lot sheet flow to the meadow. In storm events that are large enough to generate flows from the existing developed area of Santa's Village and the parking lot, storm water runoff would be expected to pick up sediment and debris (bark chips) and convey them to the meadow and incised channel of Hook's Creek. Sediment and debris are deposited in the meadow and in the pond.

Per the NRCS Drawings and Specifications for the Lined Waterways or Outlet and Water & Sediment Control Basins a water and sediment control basin will be constructed directly south of the existing parking lot. The outflows from this basin will be conveyed via a rock lined waterway to two additional water and sediment basins, in series, before outletting to the existing pond. All stormwater runoff from the developed areas of SkyPark south of SR-18 will be directed to the series of debris basins. Sediment, trash, and debris that are conveyed in stormwater runoff from the developed areas of SkyPark will settle out in this basin and will be removed from the basin through regular maintenance of the basin.

As outlined in the NRCS' Drawings and Specifications, the purpose of the water and sediment basins is to be applied as part of a resource management system for one or more of the following: to reduce watercourse and gully erosion; to trap sediment; to reduce and manage onsite and downstream runoff. The lined waterway and water and sediment control basins were designed by a qualified NRCS engineer in accordance with NRCS standards and guidelines. The lined waterway and water and sediment control basins will provide stormwater runoff control and water quality treatment for the stormwater runoff from the developed areas of SkyPark (north of SR-18) prior to discharge to the undisturbed portion of Hooks Creek onsite (downstream of the pond) and offsite.

B4.10: Refer to Response to Comment B4.9 above.

B4.11: Refer to Response to Comment B4.9 above.

B4.12: Peak hour trips used in traffic analyses are not intended to represent the greatest number of all vehicles on a roadway at a given time or the greatest traffic congestion. Peak hours, as used in the Traffic Impact Analysis, are the days and times when the greatest number of trips are generated from a project. For the SkyPark project, it was determined with consultation with Caltrans and the County that intersection traffic impacts would be evaluated for Saturday and Sunday during the morning peak hours (9:00 am to 11:00 am) when the highest number of park guests will be arriving and afternoon peak hours (2:30 pm to 4:30 pm) when the highest number of park guests will be departing. Therefore, peak hour trips are specific to the days and times when the Project generates the greatest number of trips.

Traffic counts are taken to determine the existing intersection traffic volumes, or existing conditions. For the purposes of the Traffic Impact Analysis the peak hour trips generated by a given project are added to the existing intersection conditions to determine impacts from that project on the condition of various intersections. The traffic counts were taken on a Saturday and Sunday during the morning and afternoon peak hour timeframes for the SkyPark project.

As outlined in the Traffic Impact Analysis, Appendix I of the DEIR, page 1 "The methodology and assumptions used in this analysis were established in conjunction with the interim *Traffic Impact Study Guidelines* (County of San Bernardino Department of Public Works Traffic Division, April 2014) as well as with the California Department of Transportation (Caltrans). The analysis presented in this traffic study incorporates all previous response to comments from Caltrans and the County of San Bernardino staff on earlier draft reports; specific comments are available in the appendices." The Traffic Impact Analysis, including traffic counts, was prepared in accordance with State and local standards.

It is acknowledged that bad weather, such as snow or ice on the roads, dense fog, and/or heavy rain creates dangerous driving conditions and can adversely affect traffic. It is anticipated that when the weather is bad less visitors would travel to the mountains and to SkyPark. Therefore, bad weather would be anticipated to result in less trips to and from the Project not an increase in trips.

B4.13: The Skypark traffic analysis did include a Year 2035 cumulative analysis that reviewed the SANBAG long-range computer model that projects traffic to represent buildout conditions. To the extent that the Church of the Woods project does proceed, the land use assumptions in the long-range model would include development on that site.

Church of the Woods is a proposed future project however it has not been approved by the County. A Notice of Preparation of Environmental Impact Report for the Church of the Woods Project for a tentative parcel map and conditional use permit was posted on the County's website February 10, 2005. A Notice of Availability of the Draft Environmental Impact report for the Church of the Woods Project was posted on the County's website for a public review comment period from April 19, 2010 until June 3, 2010. The Church of the Woods project proponents have informed the County that the proposed project is being revised. As the Church of the Woods project is not an approved project, the County cannot require it to be analyzed in the SkyPark Traffic Impact Analysis and DEIR. Further, since the proposed Church of the Woods project is being revised it would be speculative to try to identify the actual trips generated from the revised Church project to include in a cumulative analysis for the SkyPark project.

However, it was the applicant's decision to have the traffic consultant conduct a cumulative analysis including the SkyPark and the Church of the Woods project, using the information contained in the Church of the Woods Traffic Study for the 2010 DEIR which is still available on the County's website (http://cms.sbcounty.gov/lus/Planning/Environmental/Mountain.aspx). The following paragraph is an excerpt from the make this clear, here is an excerpt describing the projected trip generation of the Church of the Woods traffic impact analysis:

"The Sunday peak hour trip generation was calculated based on estimated church attendance. The church will have two Sunday services: 8:30 to 10:00 a.m. and 11:00 a.m. to 12:30 p.m. There will be one hour between services, during which time the attendees from the first service will depart and the attendees of the second service will arrive. Based on current attendance and future projections, it is expected that each service will have 500 attendees by 2009 and 1,200 attendees by 2013. Attendees will arrive and depart via automobiles with an average occupancy of three persons per vehicle. Based on these assumptions, the church is projected to generate 334 trips during the Sunday peak hour in 2009 and 800 trips during the Sunday peak hour in 2013 and 2030."

The projected traffic from the previous Church of the Woods traffic analysis has been added to the cumulative analysis conducted for the Skypark project, added to the DEIR as Appendix L, Cumulative Traffic Analysis with Church of the Woods. Full build-out plus project conditions (Year 2035) with Church of the Woods Project was evaluated for Saturday peak hour levels of service as well as Sunday peak hour levels of service. Even with the Church of the Woods added to the Sunday morning long-range cumulative analysis, no intersections are projected to operate at Level of Service E or F and therefore the conclusions of the Skypark EIR are still valid.

B4.14: No evidence is provided in this comment that relates to the adequacy of the traffic analysis contained in the Traffic Impact Analysis or the DEIR. The traffic analysis contained in the Traffic Impact Analysis and DEIR for the SkyPark project is thorough, adequate pursuant to CEQA, and does not need to be recirculated.

B4.15: According to SANBAG's website on the Mountain Area Transportation Study (http://www.sanbag.ca.gov/planning2/study_mtn-area-transport.html) the study is to identify and analyze the major and secondary arterials and intersections that provide access to, from, and within the San Bernardino Mountain communities. The primary goal of the effort is development of a sub-regional transportation improvement plan that identifies key projects that address both existing and forecast deficiencies during both peak summer and winter seasons. The study recommendations would not include costly new roadway facilities or realignments but would rather include operations-type capacity improvements that could then be prioritized and funded by local agencies and Caltrans. The focus is primarily on the identification of traffic bottlenecks and potential improvement options with recommendations and implementation plans.

While it is true the SR-173 at SR-18 will become more of an issue with additional development, the SkyPark Traffic Impact Study included analysis for this intersection throughout the document as one of six intersections analyzed, including pages 10, 18, 19, 25, 26, 31, 32, 44, 45, 54, and 55 among other areas of the study. The analysis contained in the Draft EIR included the project's impacts on the SR-173 at SR-18 intersection and conveyed the trips generated by the project and the impact of those additional trips on the affected roadway network per the SkyPark Traffic Impact Study results. Thus, the Traffic Impact Analysis and DEIR evaluated the intersection of SR-173 and SR-18 and found no significant project impact under Existing + Project, Opening Year + Project, and Year 2035 Cumulative + Project.

B4.16: According to SANBAG's website on the San Bernardino County CMP, 2016 Update (http://www.sanbag.ca.gov/planning2/cmp/CMP16-Complete-061416.pdf), a Congestion Management Program (CMP), under Proposition 111, is required within each county with an urbanized area having a population of 50,000 or more, to be developed and adopted by a designated Congestion Management Agency (CMA). In 1990 SANBAG was designated the San Bernardino County CMA by the County Board of Supervisors and a majority of the cities representing a majority of the incorporated population. While this interjurisdictional approach provides political and technical consistency for future development within the County, the CMP is only a mechanism to be used to guide efforts in a more efficient manner. It is not to be considered a replacement to the Regional Transportation Plan (RTP). As such, a CMP would not be a document completed by a project applicant, but rather by a CMA, or SANBAG in this context. Because there are no CMP arterial monitoring intersections in the project vicinity, no CMP analysis for compliance is required for this project. In addition, per the CMP guidelines only projects that generate greater than 250 peak hour trips require this analysis.

B4.17: It is correct that Lake Arrowhead and the Skyforest community is not located within the list of areas with a Very High Fire Hazard Severity Zone as stated in the DEIR, Section 4.8 Hazards and Hazardous Materials, page 4.8-19, as accessed on the Cal Fire website, as identified in the Section 9.0 References of the DEIR. It is also correct that the maps referenced in the comment do show the project is within a Very High Fire Hazard Severity Zone on the maps. So there is a discrepancy between the two different maps referenced. However, the DEIR analysis was based on the recognized increased fire risk of the Project site and the surrounding forested areas.

The property owner partnered with the National Resources Conservation Service (NRCS) to prepare and implement a California Cooperative Forest Management Plan (CCFMP) for the project site. The plan objective is to increase the forest's defense against fire, as well as maintain a healthy forest for recreational purposes by managing areas with overgrown chaparral and shade tolerant trees. The CCFMP also includes creation of sheltered fuel breaks along roads and near structures for future fire prevention or spread. Thus, the CCFMP is a key component in reducing the rate of spread and intensity of potential wildfires by removing, thinning, or pruning flammable vegetation to obtain a vertical and horizontal separation of fuels in the Project site. Although, the commenter identified a discrepancy in identification of the Project site within a "Very High Hazard Severity Zone," this does not change the analysis or findings in the DEIR, as the analysis contained in the DEIR already took into consideration that the Project site is in a high fire hazard area and identified mitigation measures to ensure potential impacts associated with fire risks are reduced to less than significant levels.

USDA

DRAWINGS AND SPECIFICATIONS

ENGINEERING DOCKET

SKYPARK SANTA'S VILLAGE LLC

Lined Waterway or Outlet

Water & Sediment Control Basin

Job Code: 468, 638
Farm No. : 1113
Tract No. : 18064
Engineering Class: V, II

Prepared by:
Haejin Lee
Area 4 Team Engineer
Oxnard Service Center
Ventura County

October 2015

CALIFORNIA

NATURAL RESOURCES CONSERVATION SERVICE

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

WATER AND SEDIMENT CONTROL BASIN

(No.)

CODE 638

DEFINITION

An earth embankment or a combination ridge and channel constructed across the slope of minor watercourses to form a sediment trap and water detention basin with a stable outlet.

PURPOSE

This practice may be applied as part of a resource management system for one or more of the following purposes:

- To reduce watercourse and gully erosion
- To trap sediment
- To reduce and manage onsite and downstream runoff

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to sites where:

1. The topography is generally irregular.
2. Watercourse or gully erosion is a problem.
3. Sheet and rill erosion is controlled by other conservation practices.
4. Runoff and sediment damages land and works of improvements.

Adequate outlets can be provided. Do not use this standard in place of terraces. Where the ridge and/or channel extends beyond the detention basin or level embankment, use Conservation Practice Standard (600), Terrace or (362) Diversion as appropriate.

CRITERIA

General Criteria Applicable to All Purposes

Install Water and Sediment Control Basins as part of a conservation system that adequately addresses resource concerns both above and below the basin. Where land ownership or physical conditions preclude treatment of the upper portion of a slope, a Water and Sediment Control Basin may be used to separate this area from, and permit treatment of the lower slope.

Location. Locate Water and Sediment Control Basins to control erosion in drainage ways. Basins may be installed singly or in series as part of system. Adjust the location to fit the topography, maximize storage and accommodate farm equipment and farming operations.

Earth embankment. Minimum top widths are given in Table 1. Construct embankments at least 5% greater than design height to allow for settlement. Measured from natural ground at the centerline of the embankment, the maximum settled height of the embankment must be 15 feet or less. The minimum width for vehicular traffic should be 12 feet.

Table 1. Minimum Top Width of Embankments

Fill Height (feet)	Top Width (feet)
0 – 5	3
5 - 10	6
10 –15	8

Design embankment slopes no steeper than 2 horizontal to 1 vertical. The sum of the horizontal components of the upstream and downstream slopes of the embankment must be 5 or greater. Design all slopes to be farmed no steeper than those on which farm equipment can be operated safely.

Foundation cutoff and seepage control.

Portions of basin ridges designed to impound more than a 3-foot depth of water must include foundation cutoff and if conditions warrant, seepage control. Refer to Conservation Practice Standard (378), Pond for criteria for foundation cutoff and seepage control.

Capacity. As a minimum, design Water and Sediment Control Basins with sufficient capacity to control the runoff from a 10-year frequency, 24-hour duration storm using a combination of flood storage and discharge through the outlet. Where basins are used for flood control or to protect other works of improvement, if warranted, use larger design storms appropriate to the risk.

In addition to the above storage, Water and Sediment Control Basins must have the capacity to store at least the anticipated 10-year sediment accumulation, or periodic sediment removal is required in the Operation and Maintenance Plan to maintain the required capacity.

Outlets. A Water and Sediment Control Basin must have an adequate outlet. The outlet must convey runoff water to a point where it will not cause damage. Outlets can be underground outlets, pipe drop structures, soil infiltration, stabilized channels or a combination of outlet types.

If the basin is cropped, design the outlet so that the flow release time does not exceed the inundation tolerance of the planned crops. If sediment retention is a primary design goal, adjust the release rate according to sediment particle size so that sediment is retained in the basin. Refer to Conservation Practice Standard (620), Underground Outlet for design criteria for underground outlets.

Outlets can include auxiliary spillways above the primary storage to handle large storm flows. If an auxiliary spillway is used, add freeboard to the design height of the embankment to provide for the safe operation of the spillway. The freeboard shall be at least 0.5 ft. above the design flow depth through the auxiliary spillway. Auxiliary spillways must not contribute runoff to lower Water and Sediment Control Basins unless they are designed to handle the runoff. Refer to Conservation Practice Standard (378), Pond for criteria to design auxiliary spillways.

Topsoil. Where necessary to restore or maintain productivity, spread topsoil over areas disturbed by construction. Topsoil can be salvaged and stockpiled from the site of the Water and Sediment Control Basin prior to construction.

Vegetation. After construction of the Water and Sediment Control Basin, revegetate disturbed areas that will not be cropped as soon as possible. In non-cropland settings other erosion protection such as gravel or organic mulches can also be used.

Refer to Conservation Practice Standard (342), Critical Area Planting for criteria on seed selection, seedbed preparation, fertilizing and seeding.

Additional Criteria for when the effective height exceeds 6 feet.

For effective heights greater than six feet, the water and sediment control basin shall be designed to meet the requirements of standard (378) Pond, (410) Grade Stabilization or TR-60 according to the class and type of structure.

CONSIDERATIONS

Water and Sediment Control Basins can be spaced at intervals down a slope, similar to terraces, in order to control erosion. Refer to Conservation Practice Standard (600), Terraces for methods to determine spacing. Additional conservation measures may be needed in the water course between basins to prevent erosion.

When choosing the location of a Water and Sediment Control Basin be sure to consider the extent of ponding that will occur from the basin. If the basin will cause water to pond near or across property lines both land owners should agree in writing on the elevation and expected duration of ponding.

The soil survey can be a valuable resource when planning and designing water and sediment control basins. The soil survey can identify potential problems such as the presence of limiting layers to plant growth in the soil profile. Field investigations can then identify problem areas to avoid such as shallow bedrock or dense, acid or saline layers that will adversely affect plant growth if construction brings them into the root zone.

Sediment retention within the basin can be enhanced by using flow deflectors, inlet and outlet selection, and by increasing the length to width ratio of the basin.

For cropped fields, embankment orientation and crop row direction should be approximately perpendicular to the land slope to support contour farming. The design should support farmability by limiting short point rows or sharp curves. Field boundaries and row lengths should also be considered in planning basin location and row direction.

Underground outlets from Water and Sediment Control Basins can provide a direct conduit to receiving waters for contaminated runoff from crop land. To reduce the impact of this runoff, Water and Sediment Control Basins should be installed as part of a conservation system that includes such practices as grassed waterways, contouring, a conservation cropping system, conservation tillage, nutrient and pest management, crop residue management and filter areas to reduce or mitigate contaminated runoff.

Seasonal water sources can be very important for migratory waterfowl and other wildlife. Partially blocking the outlet of a basin during non-cropping times of the year will allow water to pond in the basin to provide water for wildlife. Refer to Conservation Practice Standard (646) Shallow Water Development and Management for information on managing seasonal water sources for wildlife.

The construction of a Water and Sediment Control Basin can disturb large areas and potentially affect cultural resources. Be sure to follow state cultural resource protection policies before construction begins.

The construction of Water and Sediment Control Basins can introduce steep and potentially dangerous slopes into crop fields. When designing Water and Sediment Control Basins that will be farmed, choose flat slopes that will be safe for operating farm equipment. Where steep slopes are unavoidable, make sure that the farmer is aware of the location of the basin and the potential danger.

Cultural Resources

NRCS policy is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice or associated practices in the plan could have an effect on cultural resources. The National Historic Preservation Act may require consultation with the California State Historic Preservation Officer.

http://www.nrcs.usda.gov/technical/cultural.html is the primary website for cultural resources information. The California Environmental Handbook and the California Environmental Assessment Worksheet also provide guidance on how the NRCS must account for cultural resources. The e-Field Office Technical Guide, Section II contains general information, with Web sites for additional information.

Document any specific considerations for cultural resources in the design docket and the Practice Requirements worksheet.

Endangered Species

If during the Environmental Assessment NRCS determines that installation of this practice, along with any others proposed, will have an effect on any federal or state listed Rare, Threatened or Endangered species or their habitat, NRCS will advise the client of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the client selects one of the alternative conservation treatments for installation; or with concurrence of the client, NRCS initiates consultations concerning the listed species with the U.S. Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for Water and Sediment Control Basins that describe the requirements for applying the practice according to this standard. As a minimum the plans and specifications shall include:

1. A plan view of the layout of the Water and Sediment Control Basin system.
2. Typical cross sections of the basin(s).
3. Profile(s) of the basin(s).

4. Details of the outlet system.
5. For underground outlets, details of the inlet and profile(s) of the underground outlet.
6. Seeding requirements if needed.
7. Construction specifications that describe in writing site specific installation requirements of the Water and Sediment Control Basin system.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan for the operator. The minimum requirements to be addressed in the operation and maintenance plan are:

1. Periodic inspections, especially immediately following significant runoff events.
2. Prompt repair or replacement of damaged components.
3. Maintenance of basin ridge height and outlet elevations.
4. Removal of sediment that has accumulated in the basin to maintain capacity and grade.
5. Regular cleaning of inlets for underground outlets. Repair or replacement of inlets damaged by farm equipment. Removal of sediment around inlets to ensure that the inlet remains the lowest spot in the basin.
6. Where vegetation is specified, regular mowing and control of trees and brush. Vegetative disturbance should be scheduled to avoid the peak nesting season.
7. Notification of hazards about steep slopes on the basin.

REFERENCES

USDA, NRCS. National Engineering Handbook, Part 650 Engineering Field Handbook, Chapters 6, 8, 14.

Exhibit M

June 29, 2020

Ms. Laurel L. Impett, AICP
Shute, Mihaly & Weinberger LLP
396 Hayes Street
San Francisco, California 94102

Subject: ***Church of the Woods***
Rimforest, California

Dear Ms. Impett:

As requested, Griffin Cove Transportation Consulting, PLLC (GCTC) has completed a review of various elements of the environmental documentation associated with the proposed Church of the Woods project ("Project") in unincorporated Rimforest, California, which is located within San Bernardino County. Of particular interest were the following documents:

- *Final Environmental Impact Report – Church of The Woods Project* (T&B Planning, Inc., January 10, 2020),
- *Draft Revised Environmental Impact Report – Church of The Woods Project* (T&B Planning, Inc., January 3, 2019),
- *Church of the Woods Traffic Impact Analysis (*Translutions, Inc., September 12, 2018), and
- *Evacuation Plan – Church of the Woods Site* (Paysen, Timothy E., PhD, Revised April 2019).

Our review focused on the technical adequacy of these documents, particularly with respect to traffic operations.

BACKGROUND

The proposed project would consist of the following components:

- A 27,364-square-foot (SF) "gymnatorium,"
- A 41,037 SF assembly/children's ministry building,
- A 1,500 SF maintenance and caretaker's residence building,
- An ancillary 54,000 SF sports field and courts, and
- A 7,838 SF water quality bioretention basin.

The proposed Project would be located on the north side of State Route 18 (SR 18), between Daley Canyon Road and Bear Springs Road. Parking for 311 vehicles is also proposed on the site.

Vehicular access serving the site is proposed via a traffic signal-controlled, three-way intersection on SR 18. In addition, an emergency vehicle only driveway is proposed at a location about 325 feet to the east of the primary driveway.

The Project proposes to widen a 600-foot section of SR 18, about 300 feet in each direction from the Project driveway. The widening would accommodate an eastbound left-turn lane and a westbound deceleration/right-turn lane. Acceleration lanes would also be provided for vehicles entering the state highway in both directions.

ENVIRONMENTAL IMPACT REPORT REVIEW

Our review of the Final Environmental Impact Report (FEIR) and the Draft Revised Environmental Impact Report (DREIR) revealed several issues affecting the validity of the analysis results. These issues, which are presented below, must be addressed prior to certification of the environmental document and approval of the proposed Project by the County of San Bernardino. Those issues can generally be categorized as relating to:

- Project Traffic Impacts,
- Project Hazards, and
- Project Evacuation Plan.

<u>Project Traffic Impacts</u>

The impacts of the Project on study area traffic operations were addressed relative to "Threshold of Significance a)," which asks (DREIR, p. 3.I-8):

> *Would the Project conflict with an applicable plan, ordinance or policy establishing measures of effectiveness for the performance of the circulation system taking into account all modes of transportation including mass transit and non-motorized travel and relevant components of the circulation system, including but not limited to intersections, streets, highways and freeways, pedestrian and bicycle paths, and mass transit?*

The detailed analysis of the Project's traffic impacts is presented in the above-referenced report prepared by Translutions, Inc. The results of that analysis were summarized in "Section 3.I – Transportation and Circulation" of the environmental documents.

Several study area intersections were found to have significant and unavoidable impacts and unacceptable levels of service upon completion of the Project, even after consideration of mitigation measures. Those facilities, which are illustrated in Attachment A, include:

- Existing Plus Project Scenario
  - Intersection #4 – Bear Springs Road/State Route 18 (Saturday peak hour – LOS F / Sunday peak hour – LOS E)
  - Intersection #18 – Pine Avenue/State Route 18 (Saturday peak hour – LOS E)
- Cumulatively Considerable Impacts
  - Intersection #4 – Bear Springs Road/State Route 18 (Saturday peak hour – LOS F / Sunday peak hour – LOS F)
  - Intersection #8 – Daley Canyon Road/State Route 189 (Saturday peak hour – LOS E)
  - Intersection #10 – Daley Canyon Road/State Route 18 (Saturday peak hour – LOS F / Sunday peak hour – LOS E)
  - Intersection #11 – Daley Canyon Access Road/State Route 18 (Saturday peak hour – LOS E)
  - Intersection #17 – State Route 173/State Route 18 (Saturday peak hour – LOS F)
  - Intersection #18 – Pine Avenue/State Route 18 (Saturday peak hour – LOS F)

In the case of the Existing Plus Project Scenario, the Project impacts were designated significant and unavoidable, as there is no certainty that the mitigation measures identified for these locations can be accomplished, given that the intersections are under the jurisdiction of Caltrans and not San Bernardino County.

Similarly, the Cumulatively Considerable Impacts summarized here were also designated as significant and unavoidable. Again, as Caltrans-controlled intersections, these locations are beyond the jurisdiction of San Bernardino County. Moreover, Caltrans has no funding mechanism in place to allow for the payment of fair-share contributions for highway improvements, as called for by the pertinent mitigation measure.

Because there is no certainty that the identified mitigation measures can be accomplished, there is a reasonable likelihood that unacceptable traffic operations will continue to exist along the key study area roadways, including the primary evacuation route for Project visitors and other nearby communities, even on a "normal" day. In other words, key components of the primary evacuation route (SR 18) serving the Project site are expected to operate at or above capacity, leaving no room to accommodate a sudden influx of vehicles associated with an emergency evacuation. Traffic flow would be substantially impeded (with or without an evacuation), with congestion, stop-and-go travel conditions, and high levels of driver frustration likely to prevail.

The specific characteristics associated with operation at or above the capacity of a road are addressed in greater detail later.

<u>Project Hazards</u>

Potential traffic hazards associated with the Project were evaluated relative to "Threshold of Significance d)," which is presented at page 3.I-15 of the DREIR:

> *Would the Project substantially increase hazards due to design features (e.g., sharp curves of dangerous intersections) or incompatible uses (e.g., farm equipment)?*

Based on review of the Project's application materials, but without meaningful analysis or support, the San Bernardino County Public Works Department determined that no hazardous design features would be introduced by the Project, and the impact would be less than significant.

The FEIR further addresses this issue in Response to Comment 10-41. The comment called for an evaluation of the Project's potential to increase traffic hazards as a result of construction of the new traffic signal-controlled driveway on SR 18. Response to Comment 10-41 states:

> *The Project includes the proposed installation of a traffic signal at that [sic] intersection of the Project's driveway with SR-18. Based on AASHTO's* A Policy on Geometric Design of Highways and Streets*, the stopping sight distance on a roadway with a speed of 35 miles per hour is 287 feet on a 9% downgrade and 222 feet on a 9% upgrade. Based on review of the site plan (DREIR Figure 2-7 on DREIR p. 2-18), the new traffic signal on SR-18 will include 300 feet of stopping sight distance approaching from the west (downgrade) and over 300 feet of stopping sight distance from the east (upgrade). Therefore, there is adequate stopping sight distance between the Project's proposed driveway and curves on SR-18.*

As described in Response to Comment 10-41, the proposed intersection design provides a surplus of 13 feet of stopping sight distance in the eastbound/downhill direction; that is, 287 feet of sight distance is required and 300 feet will be provided.

However, the analysis that concluded that adequate stopping sight distance would be provided is flawed. The specific deficiencies in the analysis are addressed in detail in the following sections.

Incorrect Speed Assumption

It is incorrect to use the posted speed limit as the basis for determining whether sufficient sight distance is available. The AASHTO document referenced in Response to Comment 10-41 specifically calls for the use of the design speed, not the speed limit. The design speed is invariably higher than the speed limit; if it were equal to or less than the speed limit, then vehicles traveling at or even slightly above the speed limit would exceed the physical capabilities of the roadway. In this case, with the speed limit being 35 miles per hour (MPH), it is likely that the design speed is 40 or 45 MPH.

According to the referenced AASHTO (American Association of State Highway and Transportation Officials) document, *A Policy on Geometric Design of Highways and Streets* (Sixth Edition, 2011, pp. 3-2 – 3-5), stopping sight distance (SSD) on grades is calculated using the following formula:

$$SSD = [(1.47Vt + (1.075)(V^2/a)] + [V^2/30((a/32.2) \pm G)]$$, where:

SSD	=	Stopping sight distance (in feet)
V	=	Design speed, MPH
t	=	Brake reaction time (2.5 seconds)
a	=	Deceleration rate (11.2 feet/second^2)
G	=	Grade

The first portion of this equation computes the “brake reaction distance,” which describes how far the vehicle travels while the driver recognizes a need to stop and actually hits the brake pedal. The second element of the equation provides the braking distance (i.e., how long it takes to stop the vehicle after the brakes are applied).

Note the reference to “design speed” in the equation, rather than speed limit. Also, in this case, the factor G is equal to 0.09 for the uphill intersection approach and -0.09 for the downhill intersection approach, based on 9 percent slopes in each direction.

Using this formula, Table 1 presents stopping sight distance values for the eastbound/downhill intersection approach for design speeds ranging from 35 MPH to 45 MPH.

The first row within the table matches the 287-foot value for 35 MPH incorrectly claimed in FEIR Response to Comment 10-41. However, the second row of the table shows that the stopping sight distance for a vehicle traveling at just 1 MPH over the posted speed limit would exactly match the total distance available. For vehicles traveling 2 or more MPH over the speed limit, inadequate stopping sight distance would be provided. Such vehicles would be unable to stop in time to avoid entering the intersection if a red light is encountered or the intersection is otherwise occupied (e.g., pedestrians or bicyclists crossing against a red light or vehicles occupying the intersection because they have been involved in an earlier collision).

Table 1
Stopping Sight Distance
State Route 18/Project Driveway – Eastbound/Downhill Approach

Design Speed	Grade	Brake Reaction Distance (Feet)	Braking Distance (Feet)	Stopping Sight Distance (Feet)
35	- 9%	129	158	287
36	- 9%	132	168	300
37	- 9%	136	177	313
38	- 9%	140	187	327
39	- 9%	143	197	340
40	- 9%	147	207	354
41	- 9%	151	217	368
42	- 9%	154	228	382
43	- 9%	158	239	397
44	- 9%	162	250	412
45	- 9%	165	262	427

To ensure safe operation, a minimum of 354 feet of stopping sight distance must be provided (i.e., the value for 40 MPH) and it would be advisable to provide 427 feet, which would allow safe operation at up to 45 MPH. As noted above, these values represent the likely design speed for SR 18 at this location.

Further support for our position is provided by referring to the research document that served as the basis for the establishment of the AASHTO stopping sight distance equation: *National Cooperative Highway Research Program Report 400 – Determination of Stopping Sight Distances* (Transportation Research Board, 1997).

Particularly with regard to speed, the NCHRP document states (p. 58):

> *Recent studies have documented a noticeable disparity between design and operating speeds. A 1992 FHWA study on design consistency collected speed data at 138 horizontal curves on 29 rural two-lane highways in five states (New York, Oregon, Pennsylvania, Texas, and Washington) (80). The data in Figure 15 showed that the 85th percentile speed exceeded the inferred design speed on all but two curves whose design speed was 55 mph or less. . . . The disparity between the 85th percentile speeds and inferred design speeds is greatest for the lowest design speeds. For curves with design speeds between 25 and 40 mph, 85th percentile speeds average 11 to 12 mph faster than the design speed (80).*

For reference, Figure 15 from NCHRP Report 400 is presented as Attachment B. To clarify, the 85th percentile speed is defined as the speed at or below which 85 percent of all vehicles are observed to travel; in other words, 15 percent of the observed vehicles exceed this speed.

This strongly suggests that vehicles approaching the Project site from the west will, at a minimum, exceed the 35 MPH speed limit and will likely exceed the 40 or 45 MPH design speed. As noted above, the stopping sight distance analysis presented in the EIR fails to account for vehicle operation above the speed limit.

The NCHRP report further states:

> *This research and other studies documented in the literature show that many drivers exceed the inferred design speed (design speed calculated using current criteria and existing geometry) of horizontal and vertical curves. The consistency of these results does not support the use of initial speeds less than the roadway's design speed for determining stopping sight distance requirements.*

The inappropriate use of the posted speed limit (instead of the design speed) in determining the required safe stopping sight distance is a substantial flaw in the EIR, which calls into question the finding of a less than significant impact relative to Project hazards. In fact, it can be reasonably concluded that construction of the traffic signal-controlled Project access intersection will create a substantial traffic hazard. In particular, many drivers approaching the site on eastbound SR 18 will be unable to safely avoid any obstructions that might be present in the Project access intersection, as they will be unable to stop before entering the intersection. The result will be collisions within the intersection, which will be a direct result of construction of the Project.

Failure to Consider the Presence of Queued Vehicles

As described above, the proposed intersection design provides 300 feet of stopping sight distance in the eastbound/downhill direction, compared to a claimed requirement of 287 feet (assuming operation at 35 MPH). Thus, a surplus of 13 feet of stopping sight distance will be provided for vehicles traveling at that speed. In other words, an eastbound vehicle rounding the curve to the west of the Project driveway and needing to stop (because the signal is red or there's an obstruction in the road) will be able to stop 13 feet before entering the intersection. (Note that this assumes that the claimed 300 feet of sight distance is measured from the westerly edge of the intersection and not from the intersection's centerline.)

If there are no vehicles queued at the intersection (e.g., waiting for a red light to turn green), this will be adequate at 35 MPH. However, if there are one or more stationary vehicles on the eastbound approach to the intersection, the approaching vehicle would be unable to stop in time to avoid a rear-end collision with the last vehicle in the standing queue.

For reference, the Chevrolet website provides dimensions for each of the vehicles in their line-up. Selected vehicles have the following overall length dimensions:

- 2020 Silverado Pick-up Truck: 19.1 – 20.1 feet (depending upon passenger cab configuration),
- 2020 Tahoe Sport Utility Vehicle: 17.0 feet,
- 2021 Tahoe Sport Utility Vehicle: 17.6 feet, and
- 2020 Malibu Sedan: 16.2 feet.

Each of these vehicles is longer than the 13 feet that will be available in advance of the intersection. Thus, a queue as short as one vehicle would completely consume the excess stopping sight distance for eastbound vehicles. In other words, unless there are no vehicles waiting on the eastbound intersection approach, there will be inadequate stopping sight distance available.

The Translutions traffic impact study included a queuing analysis, but only considered the projected queues at the eastbound left-turn lane and the westbound right-turn lane. (That analysis was not included in the EIR "Transportation and Circulation" section.) Although the queuing analysis indicated that the two turn lanes would be long enough to accommodate the projected queues of vehicles, it ignored the adequacy of the eastbound and westbound through lanes.

Appendix F to the Translutions report contains the queuing analysis calculation sheets. Table 2 summarizes the projected queue lengths for the eastbound and westbound through movements for each of the study scenarios. For ease of reference, the relevant calculation sheets are presented here in Attachment C.

Table 2
Queue Length Analysis Summary[1]

Analysis Scenario	Projected Queues (Feet)			
	Eastbound Through Lane		Westbound Through Lane	
	Saturday Peak Hour	Sunday Peak Hour	Saturday Peak Hour	Sunday Peak Hour
Existing + Project	311	125	316	375
Opening Year (2018)	316	126	319	380
Cumulative (2018)	378	155	335	397
Year 2040	390	158	396	#548[2]

Notes:
1 Reference: Translutions, Inc., *Church of the Woods Traffic Impact Analysis*, September 12, 2018.
2 According to the Synchro analysis sheet, the "#" symbol indicates "95th percentile volume exceeds capacity, queue may be longer."

Looking initially at the eastbound through lane, in each of the analysis scenarios, the projected queue exceeds the 300 feet of claimed available stopping sight distance in the Saturday peak hour, with queue lengths ranging from 311 feet to 390 feet. Thus, all of the available sight distance will be consumed by standing vehicles.

In the westbound direction, the projected queues exceed 300 feet in each of the analysis scenarios on both Saturday and Sunday. In the Saturday peak hour, the queues are expected to be 316 – 396 feet long, while in the Sunday peak hour, they will be a minimum of 375 feet long. Of particular interest is the result for the Year 2040, which shows a queue of "#548" feet. As described in a footnote on the calculation sheet, the "#" symbol indicates that the "95th percentile volume exceeds capacity, queue may be longer" than 548 feet. Although the EIR (and, specifically, Response to Comment 10-41) is not specific with regard to the amount of safe stopping sight distance in the westbound direction (saying only "over 300 feet"), a queuing issue is clearly projected (although not acknowledged) in the Translutions analysis.

In summary, Response to Comment 10-41 is incorrect in claiming that adequate stopping sight distance will be available, as it completely ignores projected operational conditions at the Project access intersection with direct adverse effects on the safety of that location. Consequently, the finding of a less than significant impact with respect to Project hazards is unsupported and, more importantly, wrong.

Failure to Consider Adverse Weather Conditions

Once again, we refer to the claim that the eastbound approach to the proposed Project access intersection will have 13 feet of surplus available stopping sight distance. Recall also that this intersection approach is on a 9 percent downgrade (i.e., for every 100 feet of horizontal travel, the roadbed drops 9 feet vertically). Notwithstanding the deficiencies we have pointed out above, while this may be adequate under good (or even wet) weather conditions, its adequacy has not been proven under icy or snowy conditions.

Variations in driver skill and vehicle capability (such as the presence of anti-lock brakes or electronic traction control) become more critical under unfavorable operating conditions. While some drivers may have the acumen to safely traverse the curving, downhill grade approaching the Project site, others will not. In either case, it is reasonable to expect that stopping distances will increase, reducing the likelihood that an approaching driver will be able to stop prior to entering the intersection (or encountering the rear end of a queued vehicle).

The conclusion of a less than significant Project hazard impact is, therefore, once again called into question.

Summary

In the preceding sections we have provided detailed evidence indicating that the EIR's conclusion that the Project will have a less than significant impact with respect to Project hazards is flawed. For the reasons stated, there is little doubt that construction of the Project access intersection on SR 18 will create a hazard that will result in an increase in collisions. The severity of those collisions, as well as whether they will be restricted to vehicular collisions (or will also involve pedestrians and bicyclists) is unknown.

WILDLAND FIRE RISK ASSESSMENT REVIEW

Potential Project-related risks associated with wildland fire are addressed in Section 3.E Hazards of the EIR. In establishing the environmental setting for the Project site, that section states:

- *Wildland fire hazards are particularly acute in San Bernardino County due to its Mediterranean climate. . . . Prolonged dry periods from June to December leads [sic] to hazardous fire conditions until the winter rains start.* (DREIR, p. 3.E-1)
- *Additionally, the forested mountain areas attract visitors and due to the steep mountainous terrain, there are only five routes in and out of the area for nearly 60,000 residences in addition to visitors. These factors create severe safety hazards for the area. (San Bernardino County, 2017, p. 73)* (DREIR, p. 3.E-1)
- *The Mountain Area Safety Taskforce (MAST) is a coalition of local, State, and federal government agencies, private companies, and volunteer organizations in San Bernardino and Riverside Counties that work together to prevent and reduce the consequences of catastrophic wildfires. . . . As identified by MAST, the closest evacuation route to the Project site is Highway 18. (MAST, 2003)* (DREIR, p. 3.E-2)
- *Evacuation routes have been prepared by the Office of Emergency Services (OES) as well as MAST to ensure the efficient evacuation of all residents in the event that a wildfire or other emergency occurs. . . . The Project site is located in Area 1 as designated by MAST Mountain Area Emergency Routes. The ideal emergency routes to evacuate Area 1 are Highway 18, Highway 173, and Highway 189. In the event that the Project site requires evacuation, Highway 18, Daley Canyon Road, and Highway 189 would be used to evacuate the Project site. (MAST, 2003)* (DREIR, p. 3.E-3)

It is also important to note that:

> *According to the California Fire Hazard Severity Zone Map, the Project site is located in a "Very High Fire Hazard Severity Area" in a Local Responsibility Area.* (DREIR, p. 3.E-7)

Project Evacuation Plan

The EIR's assessment of the potential impacts related to wildfire hazards was based, in part, on review of a Project-specific evacuation plan, which was included as Technical Appendix E-1 to the EIR. (Reference: Paysen, Timothy E., PhD, *Evacuation Plan – Church of the Woods Site*, Revised April 2019) Based on information presented in the evacuation plan, the DREIR (p. 3.E-6) identifies the following preferred evacuation routes:

> *Evacuation to the south of the Project site is provided by SR-18, while evacuation to the north is available via SR-138. SR-189 provides an alternative evacuation route; however, this route would only be used by occupants of the Project site if time constraints do not exist or if there are no other alternative routes. (Payson [sic], E. T., 2017b, p. 8) In the event that a fire threatens the Project site from the south, evacuation from the Project site would be expected to occur via SR-18 and with travel towards Lake Silverwood and the I-15 freeway, or towards the Big Bear Lake area along SR-18 to the east (Payson [sic], E. T., 2017b, p.11)*

Neither the EIR nor the evacuation plan address the feasibility of these evacuation routes, however. Specifically, no attempt was made to establish whether the roads identified as the primary evacuation routes serving the Project would have adequate capacity to perform that role and, therefore, to provide a safe means of escape from an approaching wildfire.

Due to the deficiencies in the Evacuation Plan, the following basic questions remain unanswered:

1. If a wildland fire is approaching the Project site from a direction that necessitates evacuation to the south, does the two-lane SR 18 have adequate capacity to accommodate all Project- and non-Project-related traffic that might be on that road during an evacuation?
2. If a fire is approaching the Project site from a direction that necessitates travel to the north on SR 138, does that winding, two-lane road have adequate capacity to accommodate all Project- and non-Project-related traffic that might be on that road during an evacuation?
3. How long would it take to evacuate the Project site in the event of a wildland fire?
4. Most importantly, can an evacuation be successfully and safely accomplished?

Other Evacuation-Related Documents

Given the lack of meaningful information in the EIR and the Project evacuation plan, we sought out other sources to document whether a wildfire evacuation could be safely and feasibly accomplished. The most relevant information in this regard is provided in the *Mountain Region Emergency Road Capacity Study*, which was prepared, ". . . to implement certain San Bernardino County 2007 General Plan goals, policies and programs relative to evacuation of the mountain communities during emergencies . . ." (Reference: URS, *Mountain Region Emergency Road Capacity Study*, April 16, 2012, p. 1.)

That document tested the abilities of SR 18 and SR 330 to accommodate traffic during an emergency evacuation in the Lake Arrowhead area. "Scenario 1" assumed that the evacuation would occur along SR 18, while "Scenario 2" addressed an evacuation primarily occurring along SR 330. Table 3 below presents excerpts from Table 2.7-9 – Lake Arrowhead Evacuation Scenario 1 (URS, p. 30) Table 4 shows information from Table 2.7-9 – Lake Arrowhead Evacuation Scenario 2 (URS, p. 32). For reference, Attachment D presents a map from the URS study, which illustrates the road system serving the "Mountain Region Communities."

Table 3
Lake Arrowhead Evacuation Results – Scenario 1[1]
Evacuation via State Route 18

Evacuation Route	Segment	Existing			2030 Population Projection			Max. Population at General Plan Buildout		
		Evacuating Vehicles	Evacuation Speed (MPH)	Evacuation Time	Evacuating Vehicles	Evacuation Speed (MPH)	Evacuation Time	Evacuating Vehicles	Evacuation Speed (MPH)	Evacuation Time
State Route 18	SR 138 – 49th St.	8,876	--	--	7,830	--	--	36,153	--	--
	SR 138 – SR 189	8,876	-52.2	--	7,830	-40.7	--	36,153	--	--
	SR 189 – Daley Canyon Rd.	6,657	-25.5	--	5,872	-17.4	--	27,115	--	--
	Daley Canyon Rd. – SR 173	3,817	3	26	3,367	7.8	10	15,546	--	--
	SR 173 – Kuffel Rd.	1,154	33	2	1,018	32.9	2	4,700	-6.1	--
	Kuffel Rd. – SR 330	0	--	--	0	--	--	0	--	--
State Route 330	SR 18 - Highland	0	--	--	0	--	-	0	--	--

Notes:
1 Reference: URS, *Mountain Region Emergency Road Capacity Study*, April 16, 2012, Table 2.7-9 – Lake Arrowhead Evacuation Scenario 1, p. 30.
2 Highlighted cells denote negative travel speeds or missing travel speeds.

Table 4
Lake Arrowhead Evacuation Results – Scenario 2[1]
Evacuation via State Route 330

Evacuation Route	Segment	Existing			2030 Population Projection			Max. Population at General Plan Buildout		
		Evacuating Vehicles	Evacuation Speed (MPH)	Evacuation Time	Evacuating Vehicles	Evacuation Speed (MPH)	Evacuation Time	Evacuating Vehicles	Evacuation Speed (MPH)	Evacuation Time
State Route 18	SR 138 – 49th St.	0	--	--	0	--	--	0	--	--
	SR 138 – SR 189	0	--	--	0	--	-	0	--	--
	SR 189 – Daley Canyon Rd.	621	37.5	4.32	548	38.2	4	2,531	16.3	10
	Daley Canyon Rd. – SR 173	4,615	-5.2	--	4,071	0.5	156	18,799	--	--
	SR 173 – Kuffel Rd.	7,722	-37.6	--	6,812	-27.9	--	31,453	--	--
	Kuffel Rd. – SR 330	8,876	-54	--	7,830	--	--	36,153	--	--
State Route 330	SR 18 - Highland	8,876	-18.7	--	7,830	--	--	36,153	--	--

Notes:
1 Reference: URS, *Mountain Region Emergency Road Capacity Study*, April 16, 2012, Table 2.7-9 – Lake Arrowhead Evacuation Scenario 2, p. 32.
2 Highlighted cells denote negative travel speeds or missing travel speeds.

Several cells within the tables are highlighted in yellow. These highlights represent analysis results that indicate a negative travel speed, which is, obviously, not possible. This occurs within the analysis software when the traffic demand exceeds the capacity of the road. In other highlighted cells, no information is presented. Based on our experience, this suggests that the analysis parameters exceed the capabilities of the software; for example, the entered traffic volume might be greater than the analysis methodology can accommodate. One obvious example of this is the scenario addressing "Max. Population at General Plan Buildout," for which the Scenario 1 traffic volumes on SR 18 are shown to include values ranging between 15,546 and 36,153. These volumes cannot be entered into the analysis software, which only accepts traffic volumes having four digits or fewer (i.e., 9,999 or less).

To gain a greater understanding of the findings presented in the URS *Mountain Region Emergency Road Capacity Study*, we attempted to duplicate the analysis results for the segment of SR 18 between SR 189 and Daley Canyon Road using the same software employed in that work (i.e., the "Highway Capacity Software" (HCS)), which implements the methodologies documented in the 2000 *Highway Capacity Manual* (HCM) published by the Transportation Research Board. (URS, p. 7) Although not all of the pertinent analysis parameters were revealed in the URS study, we were able to match the evacuation speed results using the known parameters and reasonable assumptions about others. Our analysis results are presented in Attachment E and are summarized below.

As noted above, the "Existing" and "2030 Population Projection" evacuation speeds for this segment of SR 18 were negative numbers, indicating that the traffic demand exceeds the capacity of SR 18. This is reinforced by the "volume/capacity" (V/C) ratios provided by the HCS software, but not reported in the URS study. For "Existing" conditions, the V/C ratio for this portion of SR 18 is shown to be 4.53, while the V/C ratio for the "2030 Population Projection" scenario is 3.99. Considering that road capacity is defined to occur at V/C = 1.00, the analysis indicated that the traffic demand during an evacuation on SR 18 would be roughly four to four-and-one-half times the capacity of the road.

To further illuminate this point, according to the current version of the *Highway Capacity Manual* (Transportation Research Board, Sixth Edition, 2016), which is the most widely-accepted authority on matters relating to road capacity, the capacity of this two-lane road would reflect the following (p. 15-6):

> *A two-lane highway's capacity under base conditions is 1,700 pc/h [passenger cars/hour] in one direction, with a limit of 3,200 pc/h for the total of the two directions.*

The "base conditions" referenced here are defined as (HCM, p. 15-5 – 15-6):

- Lane widths greater than or equal to 12 feet,
- Clear shoulders wider than or equal to 6 feet,
- No no-passing zones,
- All passenger cars (i.e., no trucks) in the traffic stream,
- Level terrain, and
- No impediments to through traffic (e.g., traffic signals, turning vehicles).

Obviously, not all of these conditions apply to the pertinent segment of SR 18. For example, according to Caltrans truck volume data, at its junction with SR 173 (a short distance east of the Project site), SR 18 carries 17.3 percent trucks. To the west, SR 18 carries 18.2 percent trucks at its junction with SR 189. In addition, the roadway shoulders in the section of SR 18 are not all equal to or greater than six feet, and it certainly is not level – the URS analysis assumed that the grade of that segment was 6.9 percent overall, which affects truck travel along SR 18 (particularly with respect to slower acceleration and longer stopping distances). As noted earlier, the grade in the immediate vicinity of the Project site is 9 percent, which is even steeper than the URS assumption.

Moreover, the analysis presented in the URS study ignores several factors that directly affect roadway capacity, including:

- The possibility that the road will be obscured by smoke or that other fire-related factors (such as visible flames or flying embers) will exist that will have the effect of reducing roadway capacity; and
- The emotional state of the evacuees, which could lead to irrational or unpredictable behavior by drivers.

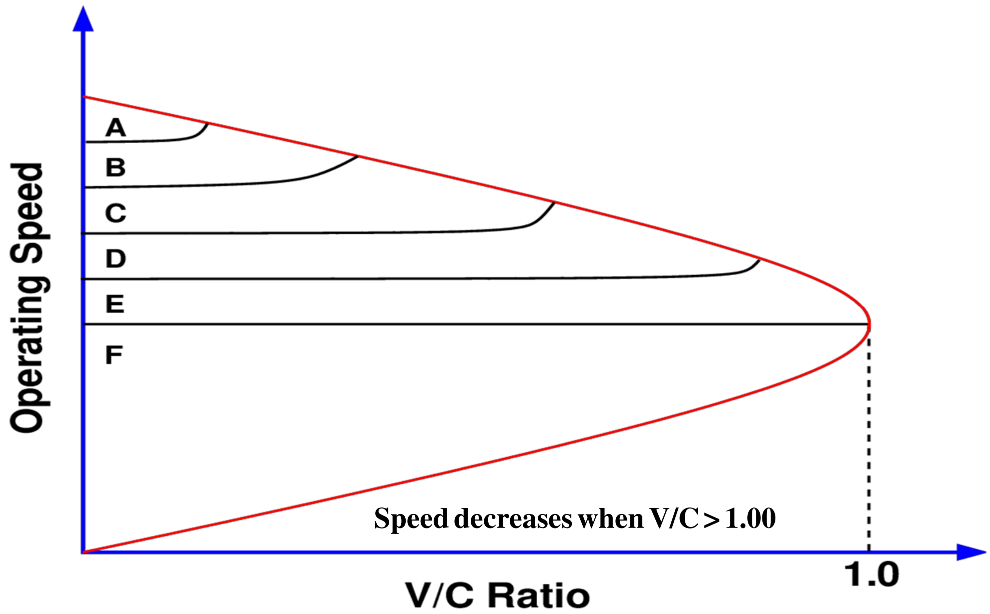
We should also note that only one lane of the two-lane highway would be available to evacuating traffic as the "inbound" traffic lane would need to be reserved for approaching emergency vehicles, as stated in Response to Comment 10-45. (FEIR, p. FEIR-163)

Consequently, the actual capacity of SR 18 would be substantially less than 1,700 passenger cars/hour. (As a side note, although it was impossible to analyze the "Max. Population at General Plan Buildout" scenario, the projected evacuating traffic volume of 27,115 on SR 18 between SR 189 and Daley Canyon Road would have a V/C ratio of about 16.0, if the road capacity were 1,700 passenger cars/hour. Given the physical characteristics of the road, its capacity is lower, so the actual V/C ratio would be even higher. Again, road capacity is defined to occur at V/C = 1.00.)

The quality of flow on a road is described in terms of "level of service" (LOS), which ranges from LOS A (free-flowing conditions) to LOS F (highly congested; V/C > 1.00). V/C ratios of 4.53, 3.99, and 16.0 indicate operation well in excess of the road's capacity and, by definition, represent LOS F. According to the *Highway Capacity Manual* (TRB, 2016, p. 12-18):

> *Oversaturated conditions are represented by LOS F. LOS F describes unstable flow. . . . breakdown occurs when the ratio of existing demand to actual capacity, or of forecast demand to estimated capacity, exceeds 1.00.*

Unstable flow will be manifested in high levels of congestion and stop-and-go traffic, which will increase not only the time needed to evacuate, but also the levels of stress and anxiety for evacuees. The following graphic illustrates the relationship between LOS and travel speed. As shown, when a roadway reaches LOS F (i.e., V/C > 1.00), the operating speed rapidly declines. We should note, however, that the speed never becomes a negative number (as suggested in the URS study).



In summary, although neither the EIR nor the Project evacuation plan address the feasibility of safely accomplishing a wildfire-related evacuation, the URS *Mountain Region Emergency Road Capacity Study* demonstrates conclusively that inadequate road capacity exists and the likelihood of a safe evacuation is negligible, at best.

Lack of Available Evacuation Routes

A significant issue for evacuations is the relative lack of available routes. As noted above, the Project Evacuation Plan (p. 8) identifies SR 18, SR 138, and SR 189 as the primary evacuation routes, although SR 189 ". . . should only be chosen if serious constraints are not present (or, if there is no other choice) . . ." This conditional recommendation regarding the potential use of SR 189 suggests that, in reality, there are only two reliable escape routes from the Project area – SR 18 and SR 138.

However, SR 138 is also subject to significant, longstanding constraints on its use. Although it is the only evacuation route to the north from the Project area, it is a very narrow, steep, winding road with hairpin turns that are difficult for large vehicles to negotiate. Caltrans has installed advisory signs warning against use of this highway by large trucks, but no enforceable truck prohibition is in place. Attachment F illustrates the existing truck advisory sign.

An article in the Alpenhorn News describes recent discussions regarding this roadway. (Reference: Alpenhorn News, Douglas W. Motley, "Proposal to Ban Big Rigs on Hwy. 138 Backside Moves Forward," February 18, 2017.) According to that article, which is presented here as Attachment G:

> *In a February 7 presentation by Jerome ("Punch") Ringhoffer before the Crest Forest Municipal Advisory Council, it was suggested that a ban on big rig semi-trucks and other large vehicles traversing the backside of Highway 138 between Valley of Enchantment and Silverwood Lake is necessary to protect public safety during an emergency evacuation scenario.*

> *Ringhoffer, retired Twin Peaks Sheriff's Station Commander – who later became the Department's Deputy Chief – recalled several past instances when big rigs using the only available northbound escape route from the west end of the San Bernardino Mountains had jackknifed on the winding highway, completely blocking traffic in both directions. Gridlock created by such an incident, he pointed out, could turn deadly in the event of a wildland fire, such as 2003's devastating Old Fire.*
>
> *According to a report from Rim of the World Mountains Mutual Aid Association President Aaron Scullin, Highway 138 is frequently partially or completely blocked by semi-trucks, trailers and other oversized vehicles unable to negotiate the switchbacks, or in winter conditions unable to maintain sufficient traction. Scullin also cited tour buses as being prone to becoming stuck.*

Clearly, consideration of SR 138 as a primary evacuation route for the Project is inappropriate, as it is simply not reliably available.

A May 8, 2019 article published in the Victorville Daily Press further addressed the issue of a lack of available evacuation routes. (Reference: Victorville Daily Press, Matthew Cabe, "Big Bear's Fire Escape Routes High Risk," May 8, 2019.) For reference, that article is presented here as Attachment H. Although the article specifically describes conditions in the Big Bear Valley, the issues described there also apply to the Project area. Excerpts from that article follow:

- *There are three main routes out of the Big Bear Valley, but what happens when one of those routes proves too dangerous for evacuations during a large-scale wildfire?*

  That question became a reality during the Old Fire, which burned more than 91,000 acres after joining the Grand Prix Fire in October 2003.

- *"The first communities that were evacuated were Lake Arrowhead and Running Springs, and the evacuation route that most chose was coming to Big Bear," [Big Bear Fire Department Chief Jeff] Willis said. "A few days later . . . the Big Bear community needed to be evacuated, so we experienced a situation where we were artificially high (in population)."*

  The three routes out of the Big Bear Valley are highways 330, 38, and 18, Willis said. During the Old Fire, an estimated 80,000 full-time residents were evacuated from the San Bernardino Mountains between Oct. 25 and Oct. 29, according to a 2003 Daily Press report.

  Evacuees in Big Bear experienced a 28-mile traffic jam into Lucerne Valley on Highway 18. Willis said that route was shut down, which "forced the issue on the other two" highways.

  Ultimately, the Old Fire never reached Big Bear and none of the six deaths occurred there, but the small number of routes available for evacuations remains a pressing issue.

Interestingly, the Evacuation Plan (p. 11) specifically states:

> *Should a fire emerge from the South, and accurate knowledge of its location is unknown, then a "wait and see" approach to evacuation is not wise. People on site should leave immediately by way of Highway 18, and set a destination for either Lake Silverwood and Interstate-15, or for the Big Bear area-continuing along Highway 18 to the east. Highways 18 and 330 to the South should not be considered.*

Thus, the recommended evacuation route would potentially lead directly to a situation identical to that experienced during the 2003 Old Fire, with a flood of evacuees who would be sitting ducks in the event that it became necessary to evacuate Big Bear at a later time.

These significant constraints in the Project-area road system reinforce the need to provide a comprehensive evacuation plan, including detailed analysis of the ability of that system to accommodate the surge of traffic that would occur in the event of a wildland fire.

The DREIR (p. 3.E-6) attempts to minimize the impacts of the Project by stating that:

> *Due to the nature of the proposed use of the Project as a community church, the vast majority of the site occupants are anticipated to already live in the nearby mountain communities; therefore, the Project would not meaningfully change the number of people requiring evacuation down the mountain during a major wildfire.*

This statement ignores the fact that the Project would result in the concentration of 900 individuals in one location, which might complicate the evacuation process. Would those individuals feel a need to return home (to retrieve goods, pets, or other family members, for example) before initiating their evacuation? If so, the number of trips on the roadway system would, in fact, be increased.

Even without any additional trips of this sort, as described above, experience has demonstrated that the limited number of highly-constrained evacuation routes have insufficient capacity to accommodate the expected sudden swell in traffic demand. This exacerbation of an existing deficiency clearly represents a significant Project-related impact that was not addressed in the EIR.

Summary

FEIR Response to Comment 10-43 (p. FEIR-162) asserts:

> *. . . the Project's revised Evacuation Plan . . . provides substantial evidence that emergency egress from the Project site and local area can be accomplished in a manner that provides for the safety of both Project occupants and the surrounding community.*

As demonstrated above, however, no such evidence has been provided by the evacuation plan. Simply put, the deficiencies in that document allow no such conclusion to be reached.

CONCLUSION

Our review of the environmental documentation and the "Evacuation Plan" completed in connection with the proposed Church of the Woods project in unincorporated Rimforest, California revealed several issues regarding the adequacy of the traffic analysis and the Project's evacuation plan. The deficiencies we have identified raise significant questions as to the validity of the conclusions presented in those documents with respect to Project-related impacts.

Of particular concern is the failure of the environmental analysis to identify a clear Project-related hazard at the proposed traffic signal-controlled access intersection on State Route 18. Further, the Project's evacuation plan provides no support for the finding of a less than significant impact with respect to wildland fire impacts. The evacuation plan includes no analysis addressing whether the primary evacuation routes serving the Project would have sufficient capacity to provide a safe means of escape from an approaching wildfire.

These issues must be addressed prior to approval of the proposed project and its environmental documentation by the County of San Bernardino.

We hope this information is useful. If you have questions concerning any of the items presented here or would like to discuss them further, please feel free to contact me at (906) 847-8276.

Sincerely,

GRIFFIN COVE TRANSPORTATION CONSULTING, PLLC

Neal K. Liddicoat

Neal K. Liddicoat, P.E.
Principal

Attachments

ATTACHMENT A

Intersections with Significant and Unavoidable Impacts
(Operation At or Beyond Capacity)

(Reference: Translutions, Inc., *Church of the Woods Traffic Impact Analysis,* September 12, 2018*.)*