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REVIEW OF ORANGE COUNTY TOLL ROAD (OCTR) SEDIMENT IMPACT ASSESSMENT ON SAN MATEO CREEK BY PHILLIP WILLIAMS AND ASSOCIATES

Prepared by Howard H. Chang, Ph.D., P.E.

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EXECUTIVE SUMMARY

I have reviewed the PWA studies and related letters on potential adverse impacts of the OCTR project on San Mateo Creek and the Trestles surfing area. PWA has major concerns for the OCTR project in several areas. My analyses of their concerns are described.

San Mateo Creek has large sediment storage in the stream channel. Sediment transport is controlled by the transport capacity but not by the supply. Sediment delivery by the stream channel reaching the beach is limited by how much the stream flow can move sediment but not by the amount of sediment produced in the watershed. The proposed OCTR project is in the sediment producing area of the watershed but not in the stream channel for sediment delivery.

The pavement for OCTR is less than one percent of the total drainage basin area for San Mateo Creek. The pavement reduces sediment production but the effects are compensated by the steepened surfaces along the road. For this reason, the OCTR project has insignificant effects on sediment production.

The OCTR road alignment will cross many small drainage paths. Cross drainage through

the road embankment will be provided by culverts and small bridges. Such drainage facilities are designed to the 100-yr standard; they will not detain sediment based on the flood control standard. The road project will not interfere with sediment movement from the watershed into the stream channel.

It is PWA's opinion that the OCTR project will affect cobble transport by the increased amount of finer sediment within the sediment deposit. San Mateo Creek in the Trestles surfing area is characterized by the absence of fine sediments as it has coarse bed materials of sand, gravel and cobbles. The presence of such coarse bed materials is a direct reflection of steep channel slope and high flow velocity. The high flow velocity prevents fine sediments from settling in the channel bed. The channel reach has a stream power far exceeds that required for moving the fines. The fines from the watershed are washed through the area as "through-put" load or *wash load* but not as *bed load*. Cobble transport occurs only during major storms of very high velocities. There can be no presence of fine sediments in the stream bed during such high flows to affect cobble transport. The transport of wash load is not correlated with the flow characteristics but it is controlled by the supply from the watershed. The Trestles surfing area is in a coarse sediment dominated domain, it is not subject to the deposition of fine sediments. Even if there is a major increase of sediment supply from the watershed, the fines would still travel through the area without deposition. The fines do not affect the transport of cobbles. There is no threat of increased fine sediment delivery and deposition to cause degradation of water quality.

PWA has concerns for the effects of hydro-modification and construction activities on sediment. Hydro-modification plan for the OCTR project has been developed by RBF to maintain the pre-project sediment as well as surface water runoff to insure that the project will not reduce sediment supply to the stream channel. The OCTR project will have erosion control measures during the construction stage. Complex measures for sediment and surface water runoff have been devised for impacts mitigation. The road project will not result in increased fine sediment production and delivery to the creek and the stream mouth. There is no concern that the sub-watersheds crossed by the road project will be de-stabilized. There is no impact of the project on downstream water quality.

It is PWA's opinion that increased fine sediment delivery due to the OCTR project may accumulate in the lagoon at the creek mouth to change its water quality and ecology. The steep stream reach near the creek mouth is a stream channel but not a lagoon. Only a short channel reach near the stream mouth is within tidal influence. Fine sediment constituting the wash load does not settle in the stream channel. This is particularly true in a steep channel. The OCTR project has no lagoon impacts.

My report provides more detailed description of the impacts and analyses to show that the PWA assessments of adverse impacts due to the OCTR project are not valid.

INTRODUCTION

Pursuant to the request by PACE, I have made a technical review of the Orange County Toll Road (OCTR) sediment impact assessment on San Mateo Creek by Phillip Williams & Associates (PWA). The documents reviewed are listed in the APPENDIX. PWA has determined that the OCTR project will impact the sediment processes in San Mateo Creek and the Trestles surfing area (Trestles).

My scope of work includes the following tasks:

(1) To review the technical reports prepared by PWA and related letters.
(2) To reviewed the OCTR roadway design provided by RBF.
(3) To evaluate the PWA assessment of the OCTR sediment impacts San Mateo Creek based on the sediment processes for San Mateo Creek and its watershed.

As a part of my technical review, I have downloaded an aerial photograph of San Mateo Creek from Google Earth as shown in Fig. 1. The San Mateo Creek watershed is still largely undeveloped.

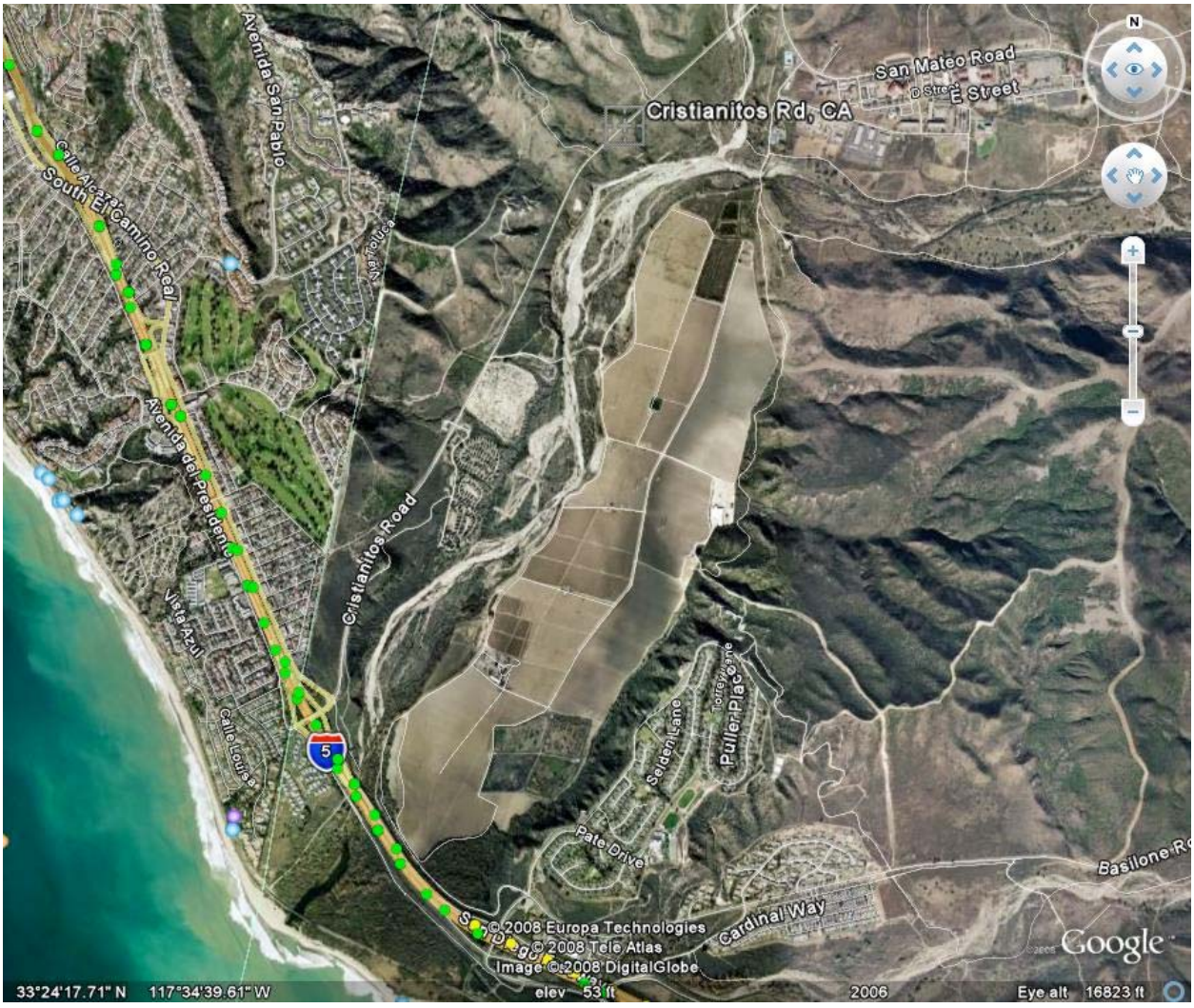

Fig. 1. Aerial photograph of San Mateo Creek

In the PWA study, the San Mateo Creek watershed was divided into several sub-watersheds. Under the proposed design, the alignment of OCTR crosses several sub-watersheds of San Mateo Creek. The PWA study provides the percentage of areas occupied by the road prism and the percentage of area made impervious. PWA has the following major concerns for the OCTR project.

(1) Disturbance to sub-watersheds near the stream mouth with higher percentage of impervious area. PWA is concerned that such disturbance would cause severe erosion and channel geomorphic degradation.

(2) Increased erosion in silt dominated sub-watersheds. Increased proportion of fine sediment delivery would result in reduction of coarse sediment delivery to Trestles sustained by cobbles.

(3) Water quality degradation caused by fine sediment.
(4) Questionable runoff management and sediment control measures. It is PWA's opinion that such measures are unlikely to control runoff of fine sediment from the road cut and fills areas during events such as the 2-yr event which contributes to the majority of sediment in the watershed.
(5) Sediment supply reduction due to hydro-modification.
(6) Increased fine sediment delivery to accumulate in the lagoon at the creek mouth to change its ecology.
(7) Cobble transport to be affected by the amount of finer sediment within the sediment deposit.
(8) De-stabilization of the watershed by the project.
(9) Construction stage sediment problems.
(10) Surf break sensitivity to sand discharge.

My analyses for their concerns are given below.

THE ISSUE OF FINE TO MEDIUM SEDIMENT

In the opinion of PWA, the OCTR would result in increased erosion in silt-dominated sub-watershed. This will cause increased proportion of fine sediment delivery to result in reduction in coarse sediment delivery to Trestles sustained by cobbles. To dispute this point, one needs to go back to the fundamental concepts in sedimentation by reviewing the **Classification of Sediment Load.** There are two common classifications of the load in a stream. The first divides the load into **bed load** and **suspended load**; the second separates the load into **wash load** and **bed-material load** (or bed-sediment load). Suspended load, by definition, moves in suspension. **Wash load** refers to the finest portion of sediment, generally silt and clay that is washed through the channel, with an insignificant amount of it being found in the bed. Wash load depends on the sediment supply from the drainage basin and it is not correlated with the flow characteristics. **Bed-material load** or bed-sediment load, on the other hand, consists of particles that are generally found in the bed material. An alluvial streambed is formed during the fluvial process of sorting, through which clay and silt are removed as wash load. The discharge of wash load depends primarily on the rate of supply; it is generally not correlated with the flow characteristics. Bed-material load, on the other hand, is usually correlated with water discharge.

A sediment transport model only computes bed material load but not the fines constituting the wash load. The transport of wash load is not correlated with the flow characteristics but it is controlled by the supply from the watershed. The Trestles surfing area is in a coarse sediment dominated domain, it is not subject to the deposition of fine sediments. There is no threat of increased fine sediment delivery and deposition to cause degradation of water quality.

In fact, fine sediment does not settle on the beach. Ocean waves does the hydraulic sorting to remove the fines thereby leaving only sand and gravel on the beach. The muddy appearance of storm water is due to wash load, which settles in deeper ocean water.

SEDIMENT PROCESSES FOR SAN MATEO CREEK

San Mateo Creek has a total drainage basin area of about 132 about square miles. It is a major stream in the Oceanside littoral cell and it is a stream without major obstructions for sediment. For many other streams, human activities such as dams, other hydraulic structures, sand and gravel mining have significantly reduced sediment delivery to the beach. According to the U.S. Army Crops of Engineers (1987), San Mateo Creek has an average annual sediment yield of 10,900 tons.

The actual sediment processes in alluvial streams are quite complex. The controlling mechanisms may be classified into the following two types:

(1) Watershed supply-controlled and

(2) Transport-capacity controlled.

For the first type of streams, sediment yield at the stream mouth is controlled by sediment supply from the watershed. For such stream, the transport capacity of the stream exceeds sediment production from the watershed and hence the yield at the stream mouth is limited by the amount of sediment supply. For the second type of streams, sediment yield at the stream mouth is controlled by the transport capacity of the stream flow. For such streams, sediment supply from the watershed exceeds the transport capacity of the stream flow; therefore, sediment delivery to

the stream mouth is limited by the sediment transport capacity of the stream flow.

According to the U. S. Army Corps of Engineers (1988), San Mateo Creek is a sediment transport capacity controlled stream. San Mateo Creek is not like many other streams in the area, such as San Marcos Creek, where human activities have reduced the alluvium in the stream bed. Such human activities include damming, channelization, sand and gravel mining, etc. have greatly reduced the sediment storage in the channel bed.

I have studied many streams in this area. It is very clear to me that sediment delivery by San Mateo Creek is sediment transport capacity controlled. This alluvial stream has a thick alluvium bed of sand and gravel. There exist no clear signs of exposed bed rock in the stream channel, indicating no channel bed degradation. The alluvial stream bed has been built up in thickness throughout geological time. With such large sediment storage in the stream channel and its floodplain, the amount of sediment delivery reaching the beach is limited by how much the stream flow can move sediment but not by the amount of sediment produced in the watershed. While the general trend of stream channel changes near the San Mateo Creek stream mouth is delta extending into the ocean and episodic deposition, there are also episodes of erosion near the river mouth, this can happen during high flow and low tides.

THE FLUVIAL SYSTEM

An alluvial stream or a river is within the domain of the fluvial system, which also consists of the drainage basin (or watershed) and the downstream reservoir, lake, or ocean. Schumm (l977) divided the fluvial system into three parts, as shown in Fig. 2. The upper part, or Zone 1, is the watershed, where most of the water and sediment for the river originate. Small streams in the area are characterized by unstable, and often braided, channels. Because of the unstable channel pattern, the study of stream morphology can only be accomplished on certain gross features but not on the details.

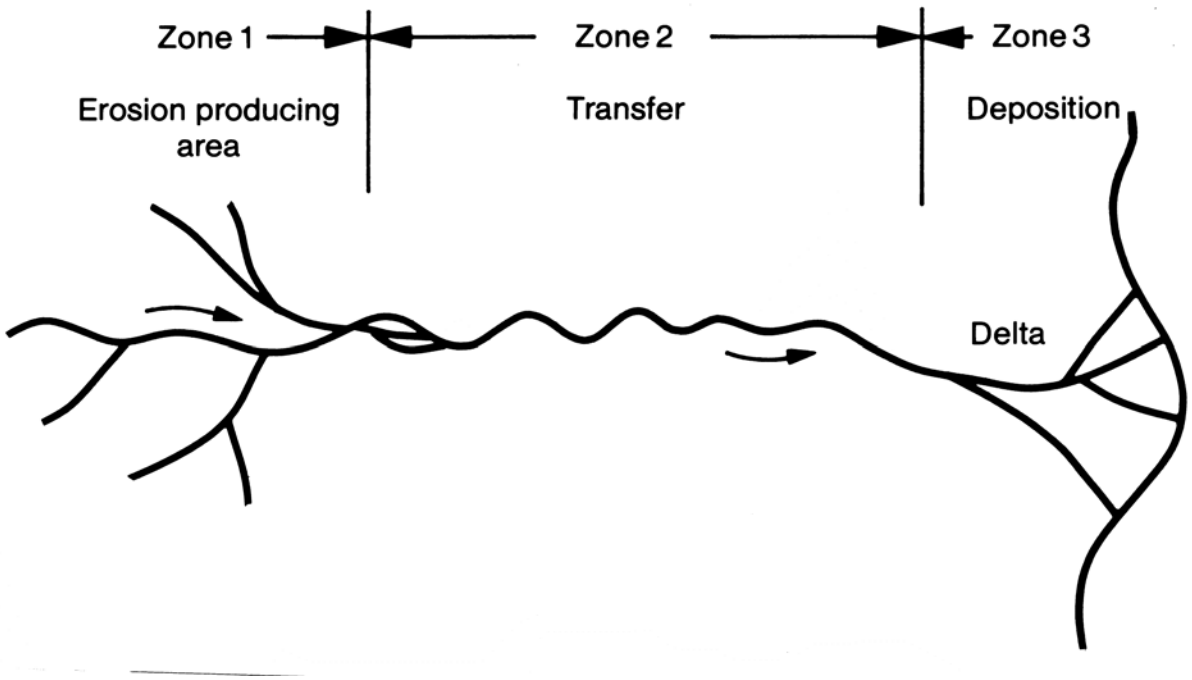

Fig. 1. The Fluvial System by Schumm (1977)

The middle part, or Zone 2, is the reach where the river channel is the most stable and where its configuration is the best defined. Large rivers have long reaches of Zone 2, but this zone may be missing in small streams. This is the reach for which extensive river studies, modeling, and control have been made. Despite the relative stability, a river channel, as a dynamic system, still undergoes changes that can be rapid and significant at times.

Zone 3 is near the river mouth, where the alluvial river is also under the influence of the tidal, or base level, variation. Because of continuous delta growth, it requires a rise in grade (aggradation) to maintain the channel slope and transport capacity. Rivers in this zone are often braided.

Figure 8 of the PWA report shows two pictures. The first picture shows active channel erosion upstream of Critianitos Road near San Onofre State Park Campsite and the second picture shows the incised channel and small developed portion of the upper watershed. These locations with erosion development are in the erosion producing area of the watershed, where sediment supply to San Mateo Creek is produced. These areas are not signs of erosion for the sediment transfer area of the stream channel. They should not be interpreted as signs of potential erosion for the stream mouth. Eroded materials from these areas are future sources of sediment for the stream channel instead.

Figure 9 of the PWA report shows two areas with erosion development. The first one is active erosion development of Calle Extremo culvert and the second one is an incised channel near the proposed OCTR road crossing. Erosion downstream of the Calle Extremo road crossing and culvert is related to the undersized culvert that has caused back water to induce sediment deposition on the upstream side of the road crossing and erosion on its downstream site. Of course, sediment detained upstream of the road crossing means reduction of sediment supply to the stream channel downstream. However, such an erosion development can be reversed if the undersized culvert can be replaced by a larger culvert or a small bridge. For the OCTR project, adequate cross drainage at the stream crossings will be provided according to the RBF design; therefore, the project will not prevent sediment from reaching San Mateo Creek. The OCTR project will not reduce sediment supply to the stream channel at the road crossings.

PROJECT IMPACTS ON SEDIMENT SUPPLY TO SAN MATEO CREEK

The road alignment for OCTR is in the sediment producing area of the San Mateo Creek watershed. The impacts of the project are on sediment supply budget, which consists of the two following components: (1) sediment production; and (2) sediment transfer. For the San Mateo Creek watershed, sediment detached from the ground surface is the sediment produced. Detached sediment then enters the numerous rills, gullies, ravens, and tributary streams before finally reaching the main stream of San Mateo Creek. The aerial photograph in Fig.1 shows numerous gullies and canyons that serve as conduits for sediment supply to the main channel.

The proposed road alignment for OCTR is through the sediment producing area of San Mateo Creek watershed but not in the sediment transport area of the stream channel. For this reason, one needs to investigate the following key points:

(1) How does the OCTR project affect sediment supply to the stream channel? and

(2) How does the road project affect sediment transport in San Mateo Creek?

The analyses for these points are described below.

Sediment production means sediment detachment from its original position by water. Factors affecting sediment production include the slope, pavement, rainfall, runoff, grain size,

acidity, etc. Road prism is a result of grading for the roadway. In constructing the road for OCTR, the slope of the ground surface is reduced. Slope reduction and road pavement will reduce sediment production. However, the natural ground surface is also steepened in the road prism. An increase of the ground surface slope means an increase of sediment production. The net effects due to roadway construction project may not be measured by the road prism alone. The pavement for OCTR is less than one percent of the total drainage basin area for San Mateo Creek. The effects of pavement on sediment production are also compensated by the steepened surfaces along the road. The OCTR project only affects 20 sub-watersheds of the San Mateo Creek drainage basin. These 20 sub-watersheds is a small percentage of the total watershed area. For these reasons, PWA has exaggerated the effects of the OCTR project on sediment production.

Now, the impacts of the OCTR project on sediment transfer is analyzed. Sediment produced in the watershed will eventually enter the stream channel. After sediment is detached from the ground surface, it moves on the ground surface and then along rills, gullies, canyons, and tributary channels. The OCTR road alignment will cross many such small drainage paths. Cross drainage through the road embankment will be provided by culverts and small bridges. Such drainage facilities will be designed to the 100-yr standard; they will not detain sediment based on the flood control standard. Since no sediment will be detained by the road embankment, the road project will not interfere with the sediment movement from the watershed into the stream channel.

PROJECT IMPACTS ON SEDIMENT TRANSPORT IN SAN MATEO CREEK

The OCTR road alignment is not in the stream channel of San Mateo Creek; therefore, it does not directly affect the stream flow or the sediment transport. However, it is still necessary to determine if the road project would impact the stream flow. Water is the agent for sediment transport. Any impact on the hydrology of the stream flow may also affect sediment movement in the stream channel. Generally speaking, an increase of the stream flow would increase sediment transport since sediment transport and sediment delivery to the beach are limited by the sediment transport capacity of the stream flow. On the other hand, a reduction of the stream flow would lower the sediment delivery to the beach.

A hydrology study has already been made for the road project. The study includes hydro-modification measures to mitigate the stream flow increase. Since the OCTR project will cause no significant changes to the pattern of stream flow, it will have no significant effects on sediment transport in the stream channel.

EFFECTS ON INCREASED SURFACE WATER RUNOFF

It is the opinion of PWA that the OCTR project will cause increase surface water runoff to result in severe erosion and channel morphology degradation. In the Psomas study, the change in surface water runoff has been found to be very small. The pavement for the OCTR project will cover less than 1% of the total watershed area. It will thus have little effects on the runoff coefficient. The road will have drainage facilities at stream and gulley crossings. The project simply will not cause severe erosion or channel geomorphic degradation. On the other hand, any increase of surface water runoff would only increase sediment production and sediment supply to the stream channel. It will have long-term effects of increased sediment storage in the stream channel and sediment delivery to Trestles.

SEDIMENT REDUCTION DUE TO HYDRO-MODIFICATION

In the opinion of PWA, the OCTR project would cause increased sediment erosion and at the same time the hydro-modification measures for the project would reduce sediment supply to the stream channel. Their report also states that proposed runoff management and sediment control measures are unlikely to control runoff of fine sediment from the road cut and fill areas during events such as the 2-yr event which contributes the majority of sediment in the watershed

Apparently, PWA did not have the chance to review the hydro-modification plan for the OCTR project which was made under the direction of RBF. The hydro-modification plan was developed to maintain the pre-project sediment as well as surface water runoff. In a letter dated January 29, 2008, Scott Taylor has already disputed the PWA assessment.

WATERSHED DE-STABILIZATION

It is PWA's opinion that the OCTR project is likely to have a significant adverse effect on the lower San Mateo Creek. PWA has raised the concern that these sub-watersheds are likely to be destabilized, resulting in increased fine sediment delivery to the creek and the lagoon.

The OCTR project will have erosion control measures during the construction stage. Complex measures for sediment and surface water runoff have been devised to for impacts mitigation. There is no concern for the said impacts.

LAGOON IMPACTS

It is PWA's opinion that increased fine sediment delivery due to the OCTR project may accumulate in the lagoon at the creek mouth to change its water quality and ecology. First of all, PWA has not provided adequate proof that the OCTR project would increase fine sediment delivery to the lagoon. Secondly, San Mateo Creek does not have a lagoon within the tidal zone. The stream channel has a steep slope in comparison to other coastal streams in the area. Only a short channel reach is within tidal influence. The stream reach near the creek mouth is a stream channel but not a lagoon. It can be seen from the aerial photograph in Fig. 1 that San Mateo Creek near Interstate 5 is a stream channel but not a lagoon. Fine sediment constituting the wash load does not settle in a stream channel in significant quantity. This is particularly true in a steep channel. The OCTR project has no such impacts.

EFFECTS OF OCTR PROJECT ON COBBLE TRANSPORT

It is PWA's opinion that the OCTR project will affect cobble transport by the increased amount of finer sediment within the sediment deposit. Deposits on the beach consist of sand, gravel and cobble that are predominantly coarse sediments. The wave action does not permit finer sediments settle on the beach. This natural hydraulic sorting process has continuously removed finer sediments. One can find finer sediments in deeper water outside the surf zone, where the wave action is weak and therefore unable to remove the fines. There is no concern or finer sediments to settle on the beach or at Trestles surfing area.

San Mateo Creek in the Trestles surfing area is characterized by the absence of fine

sediments as it has coarse bed materials of sand, gravel and cobbles. The presence of such coarse bed materials is a direct reflection of steep channel slope and high flow velocity. The high flow velocity prevents fine sediments from settling in the channel bed. The channel reach has a stream power far exceeds that required for moving the fines. The fines from the watershed are washed through the area as "through-put" load or *wash load* but not as *bed load*. Cobble transport occurs only during major storms of very high velocities. There can be no presence of fine sediments in the stream bed during such high flows to affect cobble transport. The transport of wash load is not correlated with the flow characteristics but it is controlled by the supply from the watershed. The Trestles surfing area is in a coarse sediment dominated domain, it is not subject to the deposition of fine sediments. Even if there is a major increase of sediment supply from the watershed, the fines would still travel through the area without deposition. The fines do not affect the transport of cobbles. There is no threat of increased fine sediment delivery and deposition to cause degradation of water quality.

CONSTRUCTION STAGE SEDIMENT PROBLEMS

PWA is concerned that the construction of OCTR would cause increased soil loss and erosion during the construction stage. This issue has already been considered by the project team. Under the proposed plan, such a large construction job will be carried out in multiple years. Everyone is very aware of the potential for erosion and with the visibility of the project there will be no expense spared to incorporate the most state-of- art erosion and sediment controls. A comprehensive storm water pollution prevention plan will be developed prior and specifically for the construction phase. Some of the elements that will be in the plan: (1) Soil binders and tackifiers applied before every rain on any disturbed areas, (2) Stabilizers such as bonded fiber matrix applied on areas that are at final grade, (3) A host of sediment control measures such as basins, wattles, silt fence, gravel bags etc. and (4) Scheduling to put the largest grading operations outside the rainy season.

SURF BREAK SENSITIVITY TO SAND DISCHARGE

PWA got this idea from interviews with local surfers. It is easy to understand that surf break may be affected by sand discharge. However, sand discharge at the Trestles surfing area

will not be affected by the OCTR project as detailed above. Therefore, surf break is not sensitive to the OCTR project.

CONCLUSIONS

I have reviewed the PWA studies and letters on potential adverse impacts of the OCTR project. I have also provided analyses to show that the PWA assessments of such impacts are not valid.

REFERENCES

Chang, H. H., *Fluvial Processes in River Engineering*, John Wiley & Sons, New York, NY, 1988, 432 pp.

Schumm, S. A., *The Fluvial System*, John Wiley & Sons, New York, 338 pp., 1977.

U. S. Army Corps of Engineers, "River Sediment Discharge Study San Diego Region", US Army Corps of Engineers, CCSTWS 88-3, August 1988

APPENDIX - LIST OF DOCUMENTS REVIEWED

1. Letter from David Skelly of GeoSoils, Inc. to TCA dated January 30, 2008
2. Letter from Robert Crisman and David Skelly of GeoSoils, Inc. to TCA dated October 4, 2007
3. Memorandum from David Skelly and Robert Crisman of GeoSoils, Inc. to TCA dated June 7, 2007
4. Letter from David Skelly of GeoSoils, Inc. to RBF Consulting dated April 8, 2006
5. Letter from Robert Crisman and David Skelly of GeoSoils, Inc. to RBF Consulting dated March 31, 2006
6. Letter from David Skelly of GeoSoils, Inc. to RBF Consulting dated October 5, 2004
7. Report by Skelly Engineering entitled "Impact of Foothill Transportation Corridor-South on Surfing Resources", April, 2000
8. Letter dated January 29, 2008 from Scott Taylor of RBF Consulting to TCA commenting on PWA letter of January 17, 2008

9. Letter dated January 29, 2008 from Scott Taylor of RBF Consulting to TCA commenting on PWA letter of January 22, 2008

10. Memorandum dated June 8, 2007 from Scott Taylor of RBF Consulting to TCA commenting on PWA report of January 2006

11. Letter from Mark Lindley of PWA to the California Coastal Commission dated April 11, 2008

12. Paper published in *Shore & Beach* in October 2002 entitled "Performance of Cobble Berms in Southern California" by Everts, Eldon and Moore

13. Paper published in the Proceedings for Restoring the Beach, 2001 entitled "Processes on Narrow Beaches with Sandy Foreshores and Cobble Berms" by Inman and Jenkins

14. Paper published in *Coastal Sediments '07* entitled "The Design of Stable and Aesthetic Beach Fills: Learning from Nature" by Komar

15. Paper published in *Coastal Sediments '07* entitled "Effects of Permeability on the Performance of Mixed Sand-Gravel Beaches" by She, Trim, Hom and Caming

16. Letter from Mark Lindley and Bob Battalio of PWA to the California Coastal Commission dated January 22, 2008

17. Letter from Andrew Collison and Jeffrey Haltiner of PWA to the California Coastal Commission dated January 17, 2008

18. Letter from Bob Battalio of PWA to the Surfrider Foundation August 31, 2007

19. Letter from Bob Battalio of PWA to the Surfrider Foundation May 9, 2007

20. Report entitled: "Potential Toll Road Impacts on San Mateo Creek Watershed Processes, Mouth Morphology and Trestles Surfing Area", prepared by PWA dated January11, 2006