**ATTACHMENT 2**

## Draft Summary of Key Findings and Concepts of the Joint Effort Technical Work to Date

### A. Identification of Physical Landscape Zones

The technical challenge of mapping watershed characteristics for the entire Central Coast Region is immediately apparent when one considers the Region's diverse landscape spanning a tremendous range of physiographic and ecological terrains. The Central Coast Region rises from the Santa Barbara Channel more than 4,000 feet to the top of Santa Ynez Peak in less than six miles; south of Big Sur the mountains rise almost 5,000 feet in less than four miles. In its interior, the semiarid Carrizo Plain only averages about seven inches of annual rainfall; but the mountains along the coast above Santa Cruz see more than 60 inches. The Region's primary distinguishing characteristics are a Mediterranean climate of hot dry summers and cool moist winters, giving rise to an associated vegetative cover comprising mainly of chaparral and oak woodlands, with grasslands in some lower elevations and patches of conifers at higher elevations.

Yet despite this diversity, the Joint Effort analysis revealed strong patterns in watershed processes and receiving-water conditions. From the conditions observed across the broadly undisturbed landscape areas of the Central Coast Region, fifteen landscape categories provide a regional discrimination of landscape types and dominant watershed processes in undisturbed landscapes. These categories, or, Physical Landscape Zones, are expected to express internally consistent responses to disturbance and to each benefit from the same types of management approaches to reduce the effects of urban development.

These categories were defined using just two factors that both theory and observation guide us to judge are the primary determinants of watershed processes in the "natural" (i.e., undisturbed) landscape—slope and geologic material. Other factors of potential relevance, including the spatial variability of precipitation and the influence of different vegetation types in undisturbed watersheds (e.g., trees vs. shrubs vs. grasslands in progressively drier parts of the Region) were assessed as well, and although the watershed processes that dominate on any given hillside obviously will depend on more factors than simply "slope" and "geology," observations confirm geomorphic theory that these are critical determinants of those processes. Water Board staff therefore concluded that a regional-scale stratification of the landscape based on these properties was a useful and defensible starting point for the Joint Effort analysis.

### B. Association of Key Watershed Processes with each Physical Landscape Zones

The diversity of the landscape types gives rise to an equivalent diversity of watershed processes throughout the Central Coast Region. Mapping the variety of landscape types allowed the consultants to anticipate the distribution of the most important watershed processes across that landscape, and to target the most effective stormwater management measures to protect them. Watershed processes across the landscape of the Central Coast region were anticipated to be similar to those found throughout temperate latitudes around the world, so literature characterizations and discussions formed the basis for making and interpreting field observations. Those observations were conducted across the entire Region, with two (and sometimes more) professional geomorphologists accessing every part of the Region accessible by automobile (and some more remote but unique areas by foot). Over a thousand geo-referenced photographs, accompanied by field notes, confirmed an overall consistency of the conditions and processes expressed by the intact watersheds throughout the Region with prior assessments of watershed processes.

Broadly, all but the steepest mountain ridges and the driest hillslopes are well-vegetated, whether by chaparral, coastal scrub, grasslands, oak woodlands, or evergreen forest; most hillslopes are relatively ungullied, expressing a predominance of the hydrologic processes of <u>infiltration and subsurface movement of water</u> after precipitation first falls on the ground surface. These hydrologic processes, in turn, largely control the movement of sediment and plant detrital material. Sediment movement is driven by gravity and so is negligible on flat ground regardless of the geologic material. On slopes, surface erosion (rilling, gullying) occurs only in the presence of surface flow, and its expression is rare (in undisturbed areas) except in a few very weak rock types. Landslides (and other forms of mass wasting) are more dependent on rock strength, for which the Region has excellent examples at both the weak (Franciscan mélange) and strong (crystalline rocks) ends of the spectrum. The processes were assigned ratings of “Low,” “Medium,” and “High” based on their relative importance within a particular Physical Landscape Zone.

In addition to the dominant watershed processes of <u>infiltration</u> and <u>subsurface movement of water</u>, four other processes long-recognized from prior watershed studies were included in the subsequent application of this analysis to determine effective stormwater-management strategies:

- <u>Evapotranspiration</u>**:** In undisturbed humid-region watersheds, the process of returning water to the atmosphere by direct evaporation from soil and vegetation surfaces, and by the active transpiration by plants, can account for nearly one-half of the total annual water balance; in more arid regions, this fraction can be even higher. However, there is little reason to anticipate that this fraction will materially change in different Physical Landscape Zones, so this process is presumed to have modest importance for all areas.
- <u>Delivery of sediment to receiving waters</u>**:** Sediment delivery into the channel network is a critical process for the maintenance of various habitat features in fluvial systems (although *excessive* sediment loading from watershed disturbance can also be a significant source of degradation). Quantifying this rate can be difficult and discriminating the relative contribution from different geologic materials even more so; however, the overriding determinism of hillslope gradient is widely documented. Thus, relative rates of this process are presumed to scale directly (and only) with slope class. Thus, “L” = all Physical Landscape Zones with slope 0–10%, “M” = 10–40%, and “H” = >40%.
- <u>Delivery of organics to receiving waters</u>: Unlike sediment, organic delivery is most critically dependent on the presence, width, and composition of the vegetative riparian zone. This has no systematic relationship with Physical Landscape Zone, and so (as with evapotranspiration) this is presumed to have a “M” rating for all areas.
- <u>Chemical and biological transformations</u>: This encompasses the suite of watershed processes that alter the chemical composition of water as it passes through the soil column on its path to (and after entry into) a receiving water. The conversion of subsurface flow to overland flow in a developed landscape eliminates much of the opportunity for such transformations, and this loss is commonly expressed through degraded water quality. The dependency of these processes on watershed conditions is almost unimaginably complex in detail, but in general a greater

residence time in the soil should be correlated with greater activity for this group of processes. Since residence time is inversely proportional to the rate of movement, the relative importance of this process is anticipated to be inversely proportional to slope; thus, "H" = all Physical Landscape Zones with slope 0–10%, "M" = 10–40%, and "L" = >40%.

**Table 1:** Tabular summary of the observed (and observationally inferred) watershed processes in undisturbed settings, as discriminated by Physical Landscape Zones. The assigned ratings (for "Low," "Medium," and "High") are relative and apply only to a particular column; so, for example, a "H" (high) rate of creep processes will not necessarily produce as much sediment as a high rating for rilling and gullying (indeed, the opposite will be true); but an "H" for creep will produce more sediment than an "L" for creep in a different zone. Compare to Table 2-3, which evaluates the effects of disturbance on these processes.

| Slope class | Geologic unit | WATERSHED PROCESS | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Overland flow (incl. sheetwash) | Infiltration | Interflow | Groundwater recharge | Creep | Rilling and gullying | Landsliding |
| 0–10% | Franciscan mélange | L | L | L | L | L | L | L |
| | Pre-Quaternary crystalline | L | L | L | L | L | L | L |
| | Early to Mid-Tertiary sed. | L | H | M | H | L | L | L |
| | Late Tertiary sediments | L | H | M | H | L | L | L |
| | Quaternary deposits | L | H | M | H | L | L | L |
| 10–40% | Franciscan mélange | M | L | L | L | M | M | M |
| | Pre-Quaternary crystalline | M | L | L | L | L | L | L |
| | Early to Mid-Tertiary sed. | L | M | M | M | L | L | L |
| | Late Tertiary sediments | L | H | M | H | M | M | L |
| | Quaternary deposits | L | H | M | H | M | H | M |
| >40% | Franciscan mélange | M | L | L | L | H | M | H |
| | Pre-Quaternary crystalline | M | L | L | L | L | M | L |
| | Early to Mid-Tertiary sed. | M | M | M | M | L | M | L |
| | Late Tertiary sediments | M | M | M | M | M | H | H |
| | Quaternary deposits | M | M | M | M | M | H | H |

## C. Key Watershed Processes and Stormwater Management Strategies

Identifying the management strategies that will be most protective of the watershed processes in any given Watershed Management Zone requires two steps: 1) filtering the key watershed processes within a Watershed Management Zone to the (potentially) shorter list whose disturbance can impair the actual downstream receiving water, and 2) associating effective management strategies with each of the uniquely defined Watershed Management Zones.

### a. Watershed Processes and Receiving Water Types

Not every watershed process influences the condition of every downstream receiving-water type equally. A simplified, binary division into those that are "significant" and "not significant" was based on the assessment of watershed processes and their influence on the variety of receiving waters, using either the observational results or the scientific foundation from the published literature (Table 2).

**Table 2:** Significance of key watershed processes on the different types of receiving waters (marked with an "X"). Note that the interrelated processes of overland flow, interflow, infiltration, and evapotranspiration, which in combination determine surface-water flow rates and volumes, are only of concern for streams and wetlands.

| | Watershed Processes | | | | | | |
|---|---|---|---|---|---|---|---|
| **RECEIVING WATER TYPE** | **Overland flow, rilling & gullying (OF)** | **Infiltration and groundwater recharge (GW)** | **Interflow (shallow groundwater mvmt.) (IF)** | **Evapotranspiration (ET)** | **Delivery of sediment to streams (DS)** | **Delivery of organic matter to waterbody (DO)** | **Chemical/biological transformations (CBT)** |
| **Streams** | X | X | X | X | X | X | X |
| **Wetland** | X | X | X | X | | X | X |
| **Lake** | | | | | | X | X |
| **Large rivers** | | | | | X | | X |
| **Marine nearshore** | | | | | X | | X |
| **Groundwater aquifers** | | X | | | | | X |

The commonality of watershed processes amongst the various Physical Landscape Zones, and the similarity of "process sensitivity" for large rivers and the marine nearshore (both are insensitive to flow rates and volumes, but are dependent on a natural rate of sediment delivery and chemical/biological transformations), permits condensation of the original 15 Physical Landscape Zones and 6 receiving-water types into a final list of nine Physical Landscape Zones and five receiving-water types (large rivers combined with marine nearshore).

With these associations, a final tabulation of the 45 unique combinations of Physical Landscape Zone' and receiving-water types can be made. The associated watershed processes that require protection in the face of urbanization, however, form an even fewer number of unique combinations, since more than one receiving water–Physical Landscape Zone combination can share the same group of potentially impaired processes.

### b. Stormwater Management Strategies and Storm Water Control Measures

Although the range of Stormwater Control Measures is very broad, they can be condensed into a few discrete groups. These are the primary categories of management actions; specific stormwater control measures associated with each of these strategies can then be chosen to address specific watershed processes requiring protection:

1. Flow control (either "volume" or "rate")
2. Preserve delivery of sediment and organics
3. Maintain soil and vegetation regime
4. Land Preservation
5. Water-quality treatment

Each of these categories of management strategies includes Stormwater Control Measures that are potentially effective at protecting each of the watershed processes. The specific choice of Stormwater Control Measure, however, is dependent on site conditions, including opportunities and constraints that will guide the designer to a particular suite of measures that will meet numerical criteria established by the Water Board and are feasible within the context of the particular site.

## E. Incorporation of Local, Site-Specific Data to Inform Final Hydromodification Control Requirements

Throughout the development of the Joint Effort Methodology, the limitations imposed by the scale of Region-wide data (primarily GIS-based) have been described. Thus, the types of actions anticipated as necessary to protect key watershed processes are evaluated and displayed by the products of the Joint Effort throughout the urban and urbanizing areas of the Region, but they cannot incorporate every local constraint that may influence the final design of a development project and its stormwater mitigation. Water Board staff acknowledge the need to incorporate local, site-specific information to inform the final hydromodification control requirements. Water Board staff will develop an approach to doing this and present it as part of the recommended regulatory strategy to be considered by the Water Board in July, 2012.