APPENDIX E - Technical Memorandum

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San Diego County Hydromodification Management Plan (HMP)

Subject: Minimum Criteria for Evaluation of Storm Water Controls to Meet Interim Hydromodification Criteria (IHC)

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San Diego NPDES Copermittees

Hydromodification Technical Advisory Committee (TAC)

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This Technical Memorandum details minimum criteria for the evaluation of storm water controls to mitigate the effects of hydromodification and meet Interim Hydromodification Criteria (IHC) set forth by the County of San Diego and its NPDES Copermittees. The IHC was prepared as mandated by Regional Water Quality Control Board Order R9-2007-0001 Provision D.1.g, which requires that IHC apply until the final Hydromodification Management Plan (HMP) is implemented. The purpose of the IHC is to prevent development-related changes in storm water runoff from causing, or further accelerating, stream channel erosion or other adverse impacts to beneficial stream uses.

As part of the HMP development, Brown and Caldwell will prepare flow control sizing tools to assess the effectiveness of hydromodification controls. Since those sizing tools are not yet available, Brown and Caldwell has prepared this memo to identify specific evaluation criteria for the design and analysis of interim condition hydromodification controls using continuous simulation hydrologic modeling. Evaluation criteria discussed herein focuses on the following items:

- Continuous Simulation Hydrologic Modeling
- Continuous Simulation Modeling Software
- Long-Term Hourly Precipitation Gauge Data
- Parameter Validation for Rainfall Losses
- Hydromodification Control Processes
- Peak Flow and Flow Duration Statistics

Continuous Simulation Hydrologic Modeling

Pursuant to criteria set forth by the San Diego Regional Water Quality Control Board and by the San Diego County Copermittees in the Interim Hydromodification Criteria, the use of continuous simulation hydrologic modeling is required to size storm water facilities to mitigate hydromodification effects. Continuous simulation modeling uses an extended time series of recorded precipitation data as input and generates hydrologic output, such as surface runoff, groundwater recharge, and evapotranspiration, for each model time step.

Continuous hydrologic models are typically run using either 1-hour or 15-minute time steps. Based on a review of available rainfall records in San Diego County, we are recommending the use of a 1-hour time step (15-minute time series rainfall data is very limited). Continuous models generate model output for each time step – in this case, hydrologic output would be generated for each hour of the continuous model. A continuous simulation model with 35 years of hourly precipitation data will generate 35 years of hourly runoff estimates, which corresponds to runoff estimates for 306,600 time steps for the 35-year simulation period.

Use of the continuous modeling approach allows for the estimation of the frequency and duration by which flows will exceed a particular threshold. The limitations to increases of the frequency and duration of flows within that geomorphically significant flow range is the key component to San Diego County's approach to hydromodification management.

For a more detailed review of continuous simulation modeling, refer to a memo prepared by Brown and Caldwell titled "Using Continuous Simulation to Size Storm Water Control Facilities" (May 2008). The memo can be accessed via the following link to the Project Clean Water web site.

http://www.projectcleanwater.org/pdf/susmp/hydromod_continuous_modeling_may_08.pdf

Continuous Simulation Modeling Software

The following public domain software models may be used to assess hydromodification controls for storm water facilities to meet Interim Hydromodification Criteria:

- HSPF - Hydrologic Simulation Program-FORTRAN, distributed by USEPA
- HEC-HMS – Hydrologic Modeling System; distributed by the US Army Corps of Engineers Hydrologic Engineering Center
- SWMM – Storm Water Management Model; distributed by USEPA

Third-party and proprietary software can be used to meet Interim Hydromodification Criteria provided that the software incorporates minimum design parameters outlined in this memo and summarized below:

- Input and output data from the software can interface with public domain software such as HSPF HEC-HMS, or SWMM. In other words, input files from the third-party software should have sufficient functionality to allow export to public domain software for independent validation.
- Rainfall data are selected according to an existing rainfall gauge location that is geographically and meteorologically similar to the project site location.
- Rainfall loss parameters used in the software can be substantiated and fully referenced.
- The software's hydromodification control processes, detailed later in this memo, are substantiated and fully referenced.

All third-party and proprietary software will be subject to more rigorous review upon the issuance of Final Hydromodification Management Plan. This review would include further testing of various development

and treatment scenarios as well as an in-depth analysis of software functionality and processes.

As stated previously, Brown and Caldwell is currently preparing flow control sizing tools to assess the effectiveness of hydromodification controls. These tools will be available in association with implementation of the final Hydromodification Management Plan (HMP).

Long-Term Hourly Precipitation Gauge Data

Use of the most applicable long-term rainfall gauge data, as opposed to the scaling of rainfall patterns from Lindbergh Field, is required to account for the diverse rainfall patterns across San Diego County. Prior to the commencement of hydromodification control modeling to meet Interim Hydromodification Criteria for a project site, the project proponent should take the following steps to ensure use of the appropriate precipitation gauge data.

- For projects in the unincorporated areas of San Diego County, the project proponent should contact the appropriate Department of Public Works (DPW) Project Manager
- For projects located in other jurisdictions within San Diego County, the project proponent should contact the jurisdiction's NPDES coordinator.

Upon preliminary review of all available San Diego County rainfall records, Brown and Caldwell has prepared 20 precipitation rain gauges for input to continuous simulation models. The gauge locations were selected to provide adequate geographic coverage of the County. Gauges were distributed among major watersheds to provide coverage in coastal, inland valley, foothill and mountain areas.

Gauge selection was further governed by minimum continuous simulation modeling requirements including the following:

- The selected precipitation gauge data set should be located near the project site to ensure that long-term rainfall records closely resemble the anticipated rainfall patterns for the site. Gauges were selected in proximity to areas planned for future development and redevelopment.
- Recording frequency for the gauge data set should be hourly (or more frequent).
- The gauge rainfall record should extend for the entire length of the record. Where the gauge record length is less than 35 years, then adjacent gauge information was used to extend the record length to 35 years.

Precipitation gauges identified by Brown and Caldwell, summarized in the Table 1 below, all have recording frequencies of one hour and recording data records of at least 35 years.

TABLE 1 – Rainfall Station Summary

Station	Elevation	Watershed
Bonita	120	Sweetwater River
Encinitas	242	Between San Elijo Creek and San Marcos Creek ocean outfalls
Escondido	645	Escondido Creek
Fallbrook	675	San Luis Rey River (near ridge with Santa Margarita River watershed)
Fashion Valley	20	Lower San Diego River
Flinn Springs	880	San Diego River
Kearny Mesa	425	San Diego River (near ridge with San Clemente Canyon watershed)
La Mesa	420	San Diego River (near ridge with Chollas Creek watershed)
Lake Cuyamaca	4,590	Upper San Diego River
Lake Heneshaw	2,990	Upper San Luis Rey River
Lake Wohlford	1,490	Upper Escondido Creek
Lindbergh Field	Near Sea Level	Coastal – San Diego Bay
Lower Otay Reservoir	491	Otay River
Morena Dam	3,075	Upper Tijuana River
Oceanside	30	San Luis Rey River
Poway	440	Los Penasquitos Canyon
Ramona	1,450	Upper San Dieguito River
San Onofre	162	North County Coastal – Pacific Ocean
San Vicente Reservoir	663	San Diego River
Santee	300	San Diego River

Sources for data used in rainfall gauge data preparation include:

- ALERT rainfall gauge information from the County of San Diego
- Historical (pre-1982) rainfall station information from the County of San Diego
- NOAA / National Climatic Data Center (NCDC)
- Western Regional Climate Center
- California Irrigation Management Information System
- California Data Exchange Center
- California Department of Forestry

Rainfall patterns in the San Diego area are highly variable between topographic regions. From the center of the active storm system, rainfall has historically decreased from north to south across the County. Analysis of long-term records indicates that seasonal rainfall in the northern portion of the County is 25-35 percent greater than in the southern portion of the County. Furthermore, the northern portion of the County has historically experienced more rain days on average as compared to the southern regions.

Rainfall patterns between coastal, foothill and mountain areas of the County are also significantly varied.

Rainfall totals in mountain areas are typically 100-200 percent greater than totals in coastal areas. As compared to Lindbergh Field daily rainfall totals, north county foothill areas typically experience 50 percent higher rainfall totals while south county foothill areas experience increases of 25-30 percent.

Upon completion of the Hydromodification Management Plan and implementation of final hydromodification criteria, the flow control sizing tool currently in development by Brown and Caldwell will automate the rainfall gauge selection process.

Parameter Validation for Rainfall Losses

In preparing computer models to assess storm water controls and meet Interim Hydromodification Criteria, rainfall loss parameters describing soil characteristics, land cover descriptions, and evapotranspiration data should be validated to prove consistency with the local environment and climatic conditions.

To meet Interim Hydromodification Criteria, soil and land cover parameter validation can be based on the following:

- Calibration to local stream flow data, where applicable. Examples of local calibration studies include, but are not limited to, TMDL modeling efforts prepared for the San Diego Regional Water Quality Control Board (*TMDL for Indicator Bacteria Project I – Beaches and Creeks in the San Diego Region*, Tetra Tech, December 2007).
- Published parameter values consistent with previous studies for San Diego County and Southern California, such as HSPF-related regional calibration studies, research projects, regional soil surveys, etc.
- Specific data prepared as part of a site-specific geotechnical investigation
- If parameters are transposed or modified from calibration efforts outside of Southern California, the source should be identified and justification should be provided stating why such data are applicable for San Diego County. Details should be provided justifying how parameters from such studies were adjusted to be applicable to San Diego conditions.
- Recommended parameter value ranges from *BASINS Technical Notice 6, Estimating Hydrology and Hydraulic Parameters for HSPF*, USEPA, July 2000.

To meet Interim Hydromodification Criteria, the evapotranspiration parameter validation process should include documentation of the source of evapotranspiration data and commentary of the effects of varying evapotranspiration patterns between the subject site and parameter data source. A full review of local pan evaporation and potential evapotranspiration data will be included as part of development of the final hydromodification flow control sizing tool.

Hydromodification Control Processes

Storm water flow control devices designed to meet Interim Hydromodification Criteria should be analyzed pursuant to the following criteria:

- Infiltration processes should be modeled with sufficient complexity to properly quantify the flow control benefit to the receiving streams. These infiltration processes should be transparent and fully documented.
- Infiltration quantification should include provisions for water head and pore suction effects for multiple layers of varying materials (i.e., ponding areas, amended soil layer, gravel layer, etc.), or provide justification why such complex processes are not included.
- Storage processes associated with each layer of the storm water device should be fully explained

and quantified.

- Device outflow curves should consider controls associated with device underdrains. The methodology by which such stage-discharge relationships are developed should be fully documented.

Peak Flow and Flow Duration Statistics

To assess the effectiveness of storm water flow control devices in mitigating hydromodification effects to meet Interim Hydromodification Criteria, peak flow frequency statistics should be developed. Peak flow frequency statistics estimate how often flow rates will exceed a given threshold. In this case, the key peak flow frequency values would be the lower and upper bounds of the geomorphically significant flow range.

It should be noted that peak annual series method may not be acceptable if the final lower flow control thresholds are based on Q_2 instead of Q_5. The need for partial-duration statistics is more pronounced for control standards based on more frequent return intervals, since the peak annual series does not perform as well in the estimation of such events. This effect is more pronounced in San Diego County's semi-arid climate, in which long periods of dry weather can skew results generated by a peak annual series method. This phenomenon has been discussed with the Hydrologic Research Center, which recommends the use of partial duration flow statistics for the San Diego HMP.

Flow duration statistics must also be summarized to determine how often a particular flow rate is exceeded. To determine if a storm water facility meets hydromodification criteria, peak flow frequency and flow duration curves must be generated for pre-project and post-project conditions. Both pre-project and post-project simulation runs should extend for the entire length of the rainfall record.

For a more detailed review of peak flow frequency and flow duration curves, refer to the aforementioned Brown and Caldwell memo titled "Using Continuous Simulation to Size Storm Water Control Facilities" (May 2008).

Conclusion

Until development of the final hydromodification flow control sizing tool is complete, alternate methods may be used to meet Interim Hydromodification Criteria, provided that adherence to specific evaluation criteria detailed in this memo is demonstrated. The information in this Technical Memorandum is subject to minor revision pending review by the County of San Diego, NPDES Copermittees, and the Technical Advisory Committee.