Attachment 1: Description of Emissions Reduction Measure Form

Title: *Low Impact Development (LID)*

Type of Measure (check all that apply):

☑ Direct regulation
☐ Monetary Incentive
☐ Voluntary
☐ Other Describe:
☐ Market-based compliance:
☐ Non-monetary incentive
☑ Alternative Compliance Mechanism

Responsible Agency: State Water Resources Control Board; Regional Water Quality Control Boards; individual municipalities

Sector:

☐ Transportation
☐ Other Industrial
☐ Agriculture
☐ Sequestration
☑ Electricity Generation
☐ Refineries
☐ Cement
☑ Other Describe: Water

2020 Baseline Emissions Assumed (MMT CO2E):

Percent Reduction in 2020:

Cost-Effectiveness ($/metric ton CO2E) in 2020: There are potential cost-savings associated with this reduction measure, but at a minimum, no associated additional costs.

Description:

Capturing and reusing stormwater runoff can greatly reduce the consumption of imported, potable water and its associated energy needs and CO_2 emissions. For example, stormwater and dry-weather runoff can be diverted and captured before flowing into surface waters. The captured runoff can then be used off-site as an alternative water source for irrigation of parklands, sporting fields, cluster housing groups, or for fire-fighting. Such water recycling reduces stormwater pollutants and saves energy in the form of less imported water. Another technique for stormwater capture and reuse is Low Impact Development (LID), which captures and reuses stormwater runoff on-site. Because of the robust contributions LID can make to reducing carbon emissions, and because it is practicable and inexpensive, we focus on it here. In addition to the LID measures discussed below, the State Water Resources Control Board also should evaluate the water and energy savings, and potential CO2E reductions from other types of stormwater capture programs.

The State Water Resources Control Board (SWRCB) and Regional Water Quality Control Boards (RWQCB) should require LID in satisfaction of new and redevelopment requirements in Phase I and Phase II municipal storm water permits. The SWRCB and RWQCBs should require

LID to be implemented with no greater than 3% connected impervious surface at all new and redevelopment projects that disturb greater than 5,000 square feet of soil.

Low Impact Development uses common sense and simple technology – strategically placed beds of native plants, rain barrels, "green roofs," porous surfaces for parking lots and roads, and other tools – to retain rainfall on site or help rainfall soak into the ground, rather than polluting the nearest water body. In effect, LID mimics nature's own filtering systems. The result is less water pollution from dirty runoff, less flooding, replenished water supplies, and often, more natural-looking, aesthetically pleasing cityscapes.

LID's benefits are particularly important in the dry climates that pervade California and much of the West. Because LID can retain all or most rainfall on-site, which in turn can be used for groundwater infiltration or other onsite water needs, in Southern California less water must be imported from the Sacramento-San Joaquin Delta or the Colorado River Aqueduct. Due to the significant amounts of energy needed to import water to Southern California, implementing LID can significantly reduce energy needs, and associated CO_2 emissions. The analysis below provides an indication of the scale of the emission reductions attainable, both in Southern California and elsewhere in California.

Further, LID strategies include vegetative and grassy swales, tree-box filters, and preserved vegetation, thereby increasing the amount of green spaces in a community. Additional green spaces can help sequester CO_2 emissions and reduce the "heat island" effect in urban areas. These emission reductions are in addition to those derived from the retention and reuse of water onsite.

Emission Reduction Calculations and Assumptions:

Dr. Richard Horner, a professor of engineering and expert in urban stormwater runoff and surface water management, prepared a report for NRDC's California Coastal Water Quality Project entitled, *Investigation of the Feasibility and Benefits of Low-Impact Site Design Practices ("LID") for Ventura County* (Feb. 2007) (attached). The study investigates the relative water quality and water reuse benefits of three levels of stormwater treatment best management practices (BMPs). The report forms the basis of the first step in calculating CO_2 emission reductions from LID.

1. First, based on Dr. Horner's report, we calculated the water savings attainable by using LID instead of conventional building techniques at each of six representative development scenarios:[1]

[1] These figures hold true for Los Angeles, Orange, and San Diego Counties due to similar rainfall patterns and soil conditions.

Table 1. Post-Development Water Saving Comparisons [a]

	MFR [b]	Sm-SFR	REST	OFF	Lg-SFR	COMM
Annual post-development water recharged from site with basic treatment BMPs	4.39-7.99	1.88-2.62	0.45-0.65	1.76-2.10	82.0-114	0.80-3.03
Annual post-development water recharged and harvested from site with LID	13.4	3.72	0.95	2.60	162.0	6.37
Annual water saved through LID per site	5.41-9.01	1.10-1.84	0.30-0.50	0.50-0.84	48.0-80.0	3.34-5.57

[a] Figures given in acre-feet.
[b] MFR (156-unit multi-family residential complex); Sm-SFR (23-unit single-family residential development); REST (3220-sq ft restaurant); OFF (7500-sq ft office building); Lg-SFR (1000-unit single-family residential development); COMM (2-acre commercial development).

2. We next determined the amount of energy needed to import water to Southern California. To convey water to Southern California from the Sacramento-San Joaquin Delta, the State Water Project ("SWP") must pump it 2,000 feet over the Tehachapi Mountains, the highest lift of any water system in the world. Pumping one acre-foot of SWP water to the region requires approximately 3,000 kWh (or 3 MWh). Southern California's other major source of imported water is also energy intensive: pumping one acre-foot of Colorado River Aqueduct water to Southern California requires about 2,000 kWh (or 2 MWh).[2]

3. The draft *Updated Macroeconomic Analysis of Climate Strategies Presented in the March 2006 Climate Action Team Report* provides standardized emission factors for electricity, including 313 kg CO_2e per MWh of electricity avoided.[3]

4. We next calculated the amount of CO_2 associated with pumping one acre-foot of water either through the SWP or Colorado River Aqueduct.

a. (.313 metric ton CO_2) x (3 MWh for SWP water) = <u>0.94 metric ton of CO_2 per acre-foot of water imported through the SWP</u>.

b. Alternatively, (.313 metric ton CO_2) x (2 MWh for Colorado River water) = <u>0.63 metric ton of CO_2 per acre-foot of water imported from Colorado River Aqueduct</u>.

5. Based on these numbers we next calculated the annual CO_2 emission reductions achievable by implementing LID instead of traditional building techniques at each of the six building scenarios in one California County. The CO_2 savings for six different building types are calculated below:

[2] NRDC, *Energy Down the Drain: The Hidden Costs of California's Water Supply* (Aug. 2004), at 2, http://www.nrdc.org/water/conservation/edrain/edrain.pdf.

[3] Climate Action Team Economics Subgroup, *Updated Macroeconomic Analysis of Climate Strategies Presented in the March 2006 Climate Action Team Report*, Public Review Draft, September 7, 2007.

Table 2. CO_2 emission reduction for six building types

	MFR	Sm-SFR	REST	OFF	Lg-SFR	COMM
Annual water saved through LID per site (in acre-feet)	5.41-9.01	1.10-1.84	0.30-0.50	0.50-0.84	48.0-80.0	3.34-5.57
CO_2 emissions reduction, for SWP, through LID per site (in metric tons)	5.09-8.47	1.03-1.73	.28-.47	.47-.79	45.12-75.2	3.14-5.24
CO_2 emissions reduction, for Colorado River, through LID per site (in metric tons)	3.41-5.68	.69-1.16	.19-.32	.32-.53	30.24-50.4	2.10-3.51

6. Theoretically, one could extrapolate total CO_2 reductions annually in California based on the total building permits issued for the above six building categories each year. These numbers, however, were not readily available. To give some sense of scale, though, we calculated CO_2 emission reductions achievable in one year in all Southern California counties by using LID techniques in each small single-family residential development (Sm-SFR) for which building permits are issued. For this category, the CO_2 emissions reduction ranges from 0.69 metric tons to 1.73 metric tons per year, per site.

Table 3. Estimated CO_2 emissions reduction in 2006 for Sm-SFR.

	Number of Sm-SFR building permits[4]	Total CO_2 emissions reduction (in metric tons)
Los Angeles	484	333.96 - 837.32
Riverside	277	191.13 – 479.21
San Diego	201	138.69 – 347.73
Orange	179	123.51 – 309.67
San Bernardino	55	37.95 – 95.15
Ventura	39	26.91 – 67.47
Kern	25	17.25 – 43.25
Imperial	22	15.18 – 38.06
San Luis Obispo	19	13.11 – 32.87
Santa Barbara	7	4.83 – 12.11
Total	1308	902.52 – 2,262.84

In summary, for Southern California, the CO_2 emission reductions from using LID at one of the smallest building sites, small single-family residential development, would range from 903 to 2,263 metric tons of CO_2 annually. Assuming projects approved in 2006 were built by the end of 2010 and had to implement LID, and assuming the number of building permits remains steady

[4] The U.S. Census Bureau keeps records on recorded and estimated residential building permits (new, privately-owned developments only) issued by County. The Bureau's category called "five or more unit buildings" (an average of about 28-unit buildings) is relatively comparable with the category we have called "small single-family residential development" (an average of 23-unit buildings). See http://censtats.census.gov/cgi-bin/bldgprmt/bldgdisp.pl (2006 data).

year to year at 1,308 building permits for small single-family residential developments in Southern California each year, then in the year 2020 the emission reductions would be 9,030 to 22,630 metric tons of CO_2.[5] This figure is only illustrative of how CO_2 reductions could occur through LID implementation. Potential CO_2 emission reductions in the year 2020, therefore, from *all* California counties,[6] for *all* development types, are significant.

One of many additional benefits of LID is increased green spaces. As an example, one 130-acre project in Arkansas updated its design to include LID practices. The original plan preserved 1.5 acres of green space while the revised plan saved 23.5 acres. Even though urban environments will likely not preserve such large swaths of land, additional trees and vegetation can help sequester CO_2 emissions and reduce the "heat island" effect in urban areas.

Cost-Effectiveness Calculation and Assumptions:

Numerous studies and projects have proven that LID often results in a cost savings over conventional building practices. One of the oldest communities in the United States to implement LID on a large scale is the Somerset Community in Prince Georges County, Maryland. The developer successfully integrated LID technologies into a 60-acre development in 1995, where 199 homes were sited on 10,000 square foot lots. The result was $916,382 in overall cost savings, or $4,600 savings per lot.[7]

Another project, the Gap Creek residential subdivision in Sherwood, Arkansas, used LID methods instead of conventional methods. The results were 17 additional lots, $4,800 less cost per lot, 23.5 acres of green spaces and parks, and ultimately, over $2.2 million in additional profit.[8]

Indeed, builders have recognized the potential cost savings with LID. The National Association of Home Builders estimates that construction cost savings of over 20% are possible by implementing LID.[9] EPA has also estimated that "big box" retailers can reduce development costs through LID.[10] And as with all new technologies, the costs of implementing LID will continue to decline as time goes on.

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[5] This figure does not account for cumulative CO_2 emissions reduction between the years 2010 and 2020. If each one of these projects were to implement LID, total cumulative emissions over a 10-year period would be 49,638 to 124,440 metric tons of CO2.

$$\sum_{j=1}^{10} j * 903 \; ; \; \sum_{j=1}^{10} j * 2{,}263$$

[6] Although CO_2 reductions are likely higher in Southern California because more energy is needed to import water to Southern California.

[7] Whole Building Design Guide, Low Impact Development Technologies, at http://www.wbdg.org/design/lidtech.php.

[8] NEMO California Partnership, *Low Impact Development (LID)*, at http://www.coastal.ca.gov/nps/lid-factsheet.pdf.

[9] NAHB Research Center, Builders Guide to Low Impact Development, at http://www.lowimpactdevelopment.org/lid%20articles/Builder_LID.pdf.

[10] Prepared by Low Impact Development Center for EPA Office of Water, *Low Impact Development for Big Box Retailers* (2005), at 7, http://lowimpactdevelopment.org/bigbox/lid%20articles/bigbox_final_doc.pdf.

Further evidence of LID's cost savings are demonstrated in Dr. Horner's report. LID's runoff prevention creates a significant economic benefit that represents substantial cost savings, as shown in Table 4 below. [11]

Table 4. Post-Development Water Saving Comparisons [a]

	MFR [b]	Sm-SFR	REST	OFF	Lg-SFR	COMM
Annual post-development water recharged from site with basic treatment BMPs	4.39-7.99	1.88-2.62	0.45-0.65	1.76-2.10	82.0-114	0.80-3.03
Annual post-development water recharged and harvested from site with LID	13.4	3.72	0.95	2.60	162.0	6.37
Annual water saved through LID per site	5.41-9.01	1.10-1.84	0.30-0.50	0.50-0.84	48.0-80.0	3.34-5.57
Value of annual LID water savings per site (untreated water)	$2,050-$3,415	$417-$697	$114-$190	$190-$318	$18,192-$30,320	$1,266-$2,111
Value of annual LID water savings per site (treated water)	$2,846-$4,739	$579-$968	$158-$263	$263-$442	$25,248-$42,080	$1,757-$2,930

Accordingly, the CO_2 emissions reductions which can be obtained through LID should have no net costs associated with them.

Implementation Barriers and Ways to Overcome Them:

Currently, there are four primary implementation barriers to LID. First, implementing LID is almost exclusively a voluntary proposition. Builders may be encouraged to implement LID, but are rarely required. This barrier can be easily overcome by requiring development projects to implement LID through stormwater permits or city ordinances. Second, restrictive local ordinances may inhibit use of LID. For example, many jurisdictions have road design requirements that mandate excessive amounts of impervious surfaces. This barrier can be overcome by promoting zoning options that allow for new development techniques. Third, it can be difficult to quantify the benefits from LID in order to determine its rate of success. Accordingly, a quantifiable standard should be developed in order to objectively assess whether the level of LID implementation being applied is adequate. Fourth, LID technologies are relatively new compared to traditional BMPs, and this unfamiliarity may pose a barrier to LID implementation. This barrier can be easily overcome through increased research and education about LID.

[11] Metropolitan Water District of Southern California ("MWD"), which supplies the Ventura County, charges $331 to $427 per acre-foot for untreated water, and $478 to $574 per acre-foot for treated water. On average, the wholesale cost of untreated water is $379 per acre-foot and treated water is $526 per acre-foot. See Metropolitan Water District of Southern California, Water Rates and Charges, at http://www.mwdh2o.com/mwdh2o/pages/finance/finance_03.html.

Potential Impacts on Criteria and Toxic Pollutants:

The reduced electricity demand from reduced water pumping will result in lower emissions of criteria pollutants from power plants. In addition, on average, LID is expected to decrease pollutant loadings to surface waters by more than 96%. The table below represents the pollutant reductions from an untreated case achievable through complete LID approach compared to conventional treatments.

The first four rows demonstrate the range of pollutant removal in runoff using conventional stormwater retention practices. The four pollutants analyzed are total suspended solids (TSS), total copper (TCu), total zinc (TZu), and total phosphorus (TP). For example, conventional stormwater BMPs will remove anywhere from 19.9% to 75.4% of total suspended solids.

The second four rows, on the other hand, demonstrate the range of pollutant removal in runoff using LID techniques. LID, for example, would remove an average of 99.3% total suspended solids from urban runoff.

Table 5. Pollutant Loading Reduction Estimates With a Full LID Approach Relative to Conventional BMPs.

	MFR[a]	Sm-SFR[a]	REST[a]	OFF[a]	Lg-SFR[a]	COMM[a]
Conventional TSS loading reduction[b]	15.7-69.9%	19.9-75.4%	22.0-80.6%	24.0-82.6%	19.9-75.4%	16.9-72.3%
Conventional TCu loading reduction[b]	0.0-74.4%	0.0-69.1%	0.0-78.2%	0.0-75.4%	0.0-69.1%	0.0-78.7%
Conventional TZn loading reduction[b]	22.7-78.4%	22.4-78.1%	22.9-84.3%	23.1-78.8%	22.4-78.1%	25.1-80.9%
Conventional TP loading reduction[b]	30.6-66.3%	41.5-70.7%	40.7-69.1%	45.9-76.2%	41.5-70.7%	20.3-55.0%
LID TSS loading reduction[c]	99.4%	99.3%	99.5%	99.4%	99.3%	89.0%[d]
LID TCu loading reduction[c]	98.1%	96.7%	98.0%	96.2%	96.7%	90.6%[d]
LID TZn loading reduction[c]	99.1%	98.8%	98.9%	98.3%	98.8%	94.8%[d]
LID TP loading reduction[c]	98.1%	98.6%	98.8%	98.7%	98.6%	83.1%[d]

[a] MFR—multi-family residential; Sm-SFR—small-scale single-family residential; REST—restaurant; OFF—office building; Lg-SFR—large-scale single-family residential; COMM—retail commercial; CDS— continuous deflective separation unit; EDB—extended-detention basin; NCIA—not connected impervious area; EIA—effective (connected) impervious area

[b] Range from Table 6 represented by treatment by CDS unit, EDB, biofiltration swale, or biofiltration strip

[c] Based on directing roof runoff to downspout infiltration trenches (MFR, Sm-SFR, REST, and Lg-SFR) or harvesting it (OFF and COMM), draining other NCIA to pervious areas, and treating EIA with sand filters

[d] If the higher rainfall at Ojai is assumed, reduction estimates for TSS, TCu, TZn, and TP would be 84.0, 86.3, 92.5, and 75.5 percent, respectively.

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