

# Codes and Standards Enhancement (CASE) Initiative For PY2014: Title 20 Standards Development

## Addendum 1 to Toilets and Urinals CASE Report

*Recommend Establishing a Maximum Performance (MaP) Threshold of 600 grams  
for all Toilets*

### Submitted to:

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Appliances and Existing Buildings Office

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## Introduction

In July 2013, the California Investor Owned Utilities Codes and Standards (IOU C&S) Team submitted the *Toilets and Urinals Water Efficiency Codes and Standards Enhancement (CASE) Report* to the Energy Commission (CEC).<sup>1</sup> The CASE Report presented the IOU C&S Team's proposed modifications to the Title 20 standards for toilets and urinals, including the recommendation that CEC adopt a minimum performance standard for toilets. At the time, the IOU C&S Team recommended that all toilets be capable of flushing at least 350 grams of waste, as tested using the Maximum Flush Performance (MaP) test procedure. However, after further research and consideration, the IOU C&S Team would like to revise its previous proposal and recommend that the minimum MaP score be increased from 350 grams to 600 grams and that a package labeling requirement be instated to help inform consumers of the toilet's waste removal performance. To minimize testing requirements associated with the higher MaP threshold, the IOU C&S Team recommends that toilet performance testing begin at 600 grams and move upwards incrementally until failure per the MaP test procedure (i.e. 600, 800, and 1000 grams). Finally, the IOU C&S Team would like to reiterate that to verify compliance with the standard, manufacturers shall be required to submit the actual MaP score of each qualifying model, not just certification that it meets the minimum allowable MaP score. The MaP score would be published in the publically-available California Appliance Database. Packaging would also be required to include a listing of the flush volume and the MaP score.

This addendum discusses the merits of increasing the MaP threshold to 600 grams. The addendum begins with justification for a more stringent performance standard. It then presents the impact on manufacturers and consumers. The addendum concludes by addressing some concerns stakeholders may have in adopting a more stringent MaP threshold.

## Justification for More Stringent Performance Standard

### Setting Performance Standard High Enough is Important to Maintain User Satisfaction

To maintain user satisfaction, it is critical that product functionality and performance is not sacrificed as efficiency improves. In the field of lighting, for example, first generation compact fluorescent lamps (CFLs) had performance problems like flickering and buzzing. As a result, many users were not satisfied with CFLs as the more efficient replacement to incandescent lamps. Toilets experienced a similar consumer backlash in the 1990s. The Energy Policy Act of 1992 established the 1.6 gallons per flush (gpf) federal standard that is still in place today. When the standard took effect, a small number of 1.6 gpf toilets did not maintain flush performance. These poorly performing products that did not meet consumers' expectations lead many consumers to lose confidence in the efficacy of low-flow toilets. Given this history, it is important that California take proactive measures to ensure that product amenity is maintained as efficiency improves. As described in the CASE Report, CEC can protect amenity by coupling the water efficiency standard with a performance standard.

After evaluating the typical loads that are flushed down toilets and the performance of toilets that are available on the market, the IOU C&S Team questions the assumption that a MaP score of 350 grams represents "acceptable performance." After a careful review of the medical data on human waste generation and the waste removal capabilities of rated toilets, the IOU C&S Team has concluded that a MaP score of 600 grams is a better indication of an acceptable level necessary for maintaining user satisfaction.

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<sup>1</sup> California Investor Owned Utilities and Natural Resources Defense Council. *Toilets and Urinals Water Efficiency. Codes and Standards Enhancement (CASE) Initiative for PY 2013: Title 20 Standards Development.* July 29, 2013. Docket number 12-AAER-2C. Available online at: [http://www.energy.ca.gov/appliances/2013rulemaking/documents/proposals/12-AAER-2C\\_Water\\_Appliances/California\\_IOUs\\_and\\_Natural\\_Resources\\_defense\\_Councils\\_Responses\\_to\\_the\\_Invitation\\_for\\_Standards\\_Proposals\\_for\\_Toilets\\_and\\_Urinals\\_2013-07-29\\_TN-71765.pdf](http://www.energy.ca.gov/appliances/2013rulemaking/documents/proposals/12-AAER-2C_Water_Appliances/California_IOUs_and_Natural_Resources_defense_Councils_Responses_to_the_Invitation_for_Standards_Proposals_for_Toilets_and_Urinals_2013-07-29_TN-71765.pdf).

## Solid Waste Events Often Exceed 350 Grams

The 350 gram threshold that is used in the WaterSense specification was derived from results of a 1978 medical study by Wyman et al. that evaluated the bowel movements of twenty healthy English subjects (ten men and ten women) eating a normal diet.<sup>2</sup> Overall, 69 individual stool collections were available for analysis. Though this sample size was not large enough to be statistically valid or representative of an entire population, it is indicative of the expected range of weight and frequency of bowel movements. After reviewing the results of this study, the IOU C&S Team concluded that setting the threshold at 600 grams would ensure that waste is successfully removed from the bowl for virtually every flush that occurs statewide.

Table 1 summarizes some of the key findings of the Wyman et al. study. There was wide variability in the average stool weight of the 20 subjects; the smallest average stool weight was 66 grams and the largest was 252 grams. The smallest individual stool of the entire sample was 6.7 grams and the largest was 452 grams. On average, subjects had a bowel movement every 27.4 hours. The longest average duration between bowel movements was 56 hours from Subject 12 and the shortest average duration was 16 hours from Subject 20. Translating this into annual bowel movements, it is estimated that that Subjects 12 and 15 will have 156 and 548 bowel movements per year, respectively.

Knowing the mean and the standard deviation of individual stools from each subject and assuming that each subject's stool samples had a normal distribution; it is possible to estimate the percentage of bowel movements that will exceed a specific threshold weight. Table 1 presents the percent of bowel movements from each subject that can be expected to exceed 350 grams. Table 1 also presents the number of individual stool samples that exceed 350 grams on an annual basis.

It is estimated that 6 out of the 20 subjects (30 percent of all subjects) will have at least one stool that exceeds 350 grams per year. Subjects 12 and 15, both men, could have a stool that exceeds 350 grams once every 13 days or 17 days, respectively. This means that 2 of the 10 men, or 20 percent of the men, are expected to flush more than 350 grams approximately twice a month.

It is predicted that over the course of a year 0.8 percent of this sample group's bowel movements will exceed 350 grams. One might contend that exceeding the 350 gram threshold less than 1 percent of the time is acceptable. However, Californians initiate about 14 billion solid waste flushes per year,<sup>3</sup> and assuming that the 350 gram threshold is exceeded 1 percent of the time, that means Californian's flush more than 350 grams 140 million times a year. This raises the important question of whether it is acceptable or advisable to set a standard that could result in waste remaining in the bowl (i.e. the toilet failing to perform as intended) so frequently. If the threshold is set at 350 grams and toilets are manufactured to be minimally compliant, waste could remain in the bowl more than 100 million times per year statewide, and 20 percent of the male population could experience flushing failures approximately twice per month. This type of performance undermines the objective of a performance standard due to the toilet not providing the level of service that consumers expect. As discussed in the next section, 91 percent of current tank-type models and 98 percent of current flushometer models already meet or exceed the proposed 600 gram MaP threshold. Therefore, increasing the minimum allowed MaP score to 600 grams would not have a significant impact on the market.

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<sup>2</sup> J. B. Wyman, K. W. Heaton, A. P. Manning, and A. C. B. Wicks *Variability of colonic function in healthy subjects*. From the University Department of Medicine, Bristol Royal Infirmary, Bristol. Gut.1978, 19, 146-150  
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1411830/pdf/gut00459-0070.pdf>.

<sup>3</sup> 38.3 million people in California x 365 solid waste flushes per person per year = 13.9 billion solid waste flushes per year statewide.

**Table 1: Stool Weight and Interval between Stools, 20 Healthy Subjects**

Subject	Mean Weight of Individual Stools (grams)	Smallest Individual Stool (grams)	Largest Individual Stool (grams)	Standard Deviation of Stool Weight (grams)	Average Stool Frequency (hours between movements)	Estimated Number of Bowel Movements per Year	Percent of Individual Stools Over 350 grams	Number of Stools Over 350 grams per Year	
Females Subjects	1	90	10.4	170.4	28.3	20.2	434	0.0%	-
	2	108	6.7	330.1	72.9	20.0	438	0.0%	-
	3	137	11.6	327.1	87.3	20.8	421	0.7%	3
	4	179	120.6	224.3	33.1	38.2	229	0.0%	-
	5	82	19.1	167.8	39.1	16.6	528	0.0%	-
	6	135	61.9	229.6	54.0	26.6	329	0.0%	-
	7	95	8.5	201.9	50.1	16.8	521	0.0%	-
	8	66	7.6	175.2	39.2	20.4	429	0.0%	-
	9	108	39.6	208.0	33.1	19.2	456	0.0%	-
	10	113	17.0	331.8	76.6	28.2	311	0.1%	-
Male Subjects	11	127	33.0	240.0	92.3	43.0	204	0.8%	2
	12	252	151.0	452.0	107.7	56.0	156	18.1%	28
	13	152	72.0	260.0	63.1	25.0	350	0.1%	-
	14	140	89.0	191.0	36.4	49.0	179	0.0%	-
	15	208	60.0	311.0	97.5	30.8	284	7.3%	21
	16	75	20.0	124.0	37.1	26.0	337	0.0%	-
	17	142	66.0	288.0	71.5	28.0	313	0.2%	1
	18	149	59.0	301.0	67.9	24.0	365	0.2%	1
	19	111	57.0	186.0	47.7	24.0	365	0.0%	-
	20	69	32.0	144.0	30.9	16.0	548	0.0%	-
ALL	127	6.7	452.0		27.4	7,197	0.78%	56	

To explore how increasing the acceptable threshold would impact the frequency of flushes in excess of the threshold value, the IOU C&S Team estimated the percentage of individual stools that would exceed the threshold by incrementally increasing weights in accordance to the weights used in the MaP testing protocol. Table 2 and Figure 1 present the results from the analysis. Increasing the threshold weight from 350 grams to 400 grams would reduce the percentage of total stool samples from 0.8 percent to 0.3 percent for all 20 subjects. However, it is still anticipated that the top twenty percent of men, represented by Subjects 12 and 15, would exceed the 400 gram threshold 4.5 percent of the time. As depicted in Figure 1, the number of times per year that the toilet would not clear the bowel movement – especially among the top 20 percent of men – significantly decreases as the MaP weight threshold increases. If the threshold is increased to 550 grams, over the course of a year virtually nobody in the study group would have a bowel movement that exceeded the threshold.

**Table 2: Number and Percent of Total Stool Samples that Exceed Various Threshold Weights**

Threshold Weight (grams)	All 20 Subjects		Subjects 12 and 15 <i>(top 20 percent of men)</i>	
	Number of Individual Stools Exceeding Threshold per Year	Percent of Total Stool Samples That Exceed Threshold Weight	Number of Individual Stools Exceeding Threshold per Year	Percent of Total Stool Samples That Exceed Threshold Weight
350	56	0.8%	49	11.1%
400	21	0.3%	20	4.5%
500	2	0.0%	2	0.5%
600	0	0.0%	0	0.0%

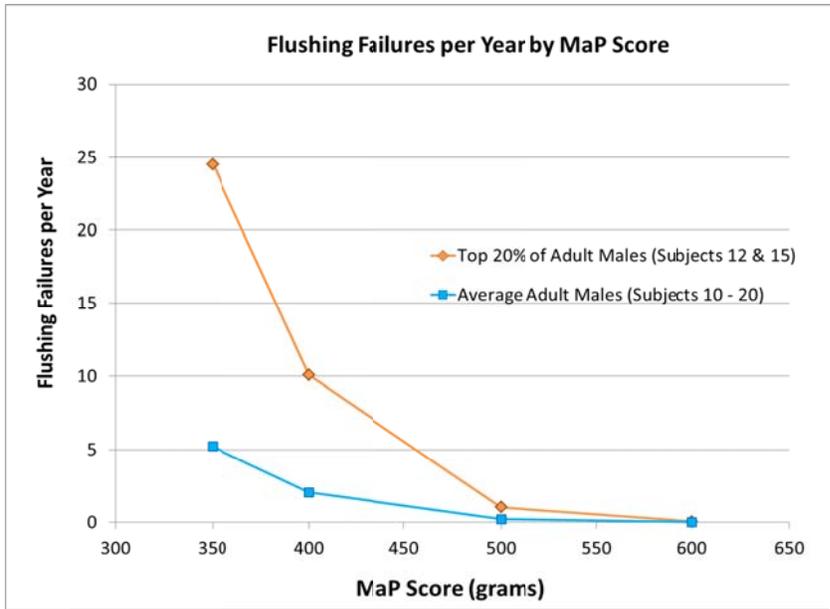


Figure 1: Annual flushing failures per year for average male and top 20 percent of males.

It should also be noted that subjects that participated in the study were provided with dietary instructions aimed at standardizing their daily fiber intake, which could reduce the weight and frequency of bowel movements. The sample size is also fairly small and may not accurately capture seasonal or cultural (holiday) variations. Further, results may be different in the United States today where many things are “super-sized” as compared to 1978 when the study was conducted. As discussed in the previous section of this addendum, the stool weight threshold also does not take the impact of toilet paper into account.

## Toilets that Meet or Exceed 600 Gram Performance Threshold are Widely Available

Evaluation of the acceptable threshold level must be considered within the context of the performance of technology that is currently available on the market. It might be reasonable to set the threshold at 350 grams if only a small fraction of toilets could exceed the 350 gram threshold without being inordinately expensive. However, 91 percent of the 1.28 gpf tank-type toilets and 98 percent of the 1.28 gpf flushometer toilets have received MaP scores that can meet a waste extraction level that meets or exceeds the proposed 600 gram threshold. Given that the vast majority of products have MaP ratings of 600 grams and higher, it is important to question the merit of adopting a performance level that is *lower* than the expected level of waste that will be flushed on a frequent basis by approximately one-fifth of households.

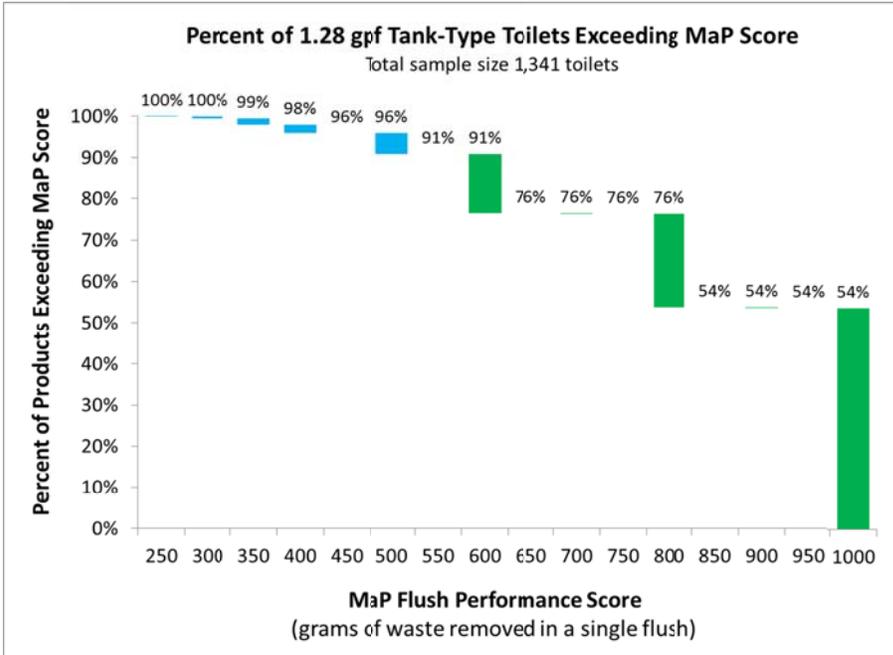
### *Performance of Tank-type Toilets*

As of December 27, 2013 the MaP database included 2,015 tank-type toilets that used 1.28 gallons or less per flush. Thirty-three percent of these 1.28 gpf (674 models) have received a NM score, which means the product was not tested to failure to determine the maximum volume of waste that can be successfully flushed.<sup>4</sup> Some of these NM products may already meet the 600 gram threshold, but they have not been tested to verify the maximum performance. Products rated as NM have were not included in the analysis presented below.

Figure 2 shows the percent of low-flow (1.28 gpf or more efficient) tank-type toilets that exceed various MaP scores. Ninety-one percent of the 1.28 gpf tank-type toilets already meet or exceed the proposed 600 gram

<sup>4</sup> To be WaterSense certified, the rules allow the manufacturer to test only at 350 grams and if the toilet passes they can certify as WaterSense certified without having to test to failure (below 1,000 grams) and are certified in the WaterSense database as “NM” (not measured).

threshold (see green bars). Looking at the data more closely, starting at the top left, approximately 0.5 percent of the products have a MaP score under 350 grams and would not qualify for the less stringent 350 gram standard. If the MaP threshold were increased from 350 grams to 600 grams, 9 percent of the 1.28 gpf products rated at 350, 400, 450, 500, and 550 grams would not qualify for the California standard. More than 1,200 products can already meet the more proposed 600 gram standard, with that number potentially increasing given that some NM products may also meet the 600 gram threshold.



**Figure 2: 1.28 gpf or More Efficient Tank-Type Toilets that Meet or Exceed Various MaP Scores**

Source: MaP Database; Tank-type toilets; December 27, 2013.

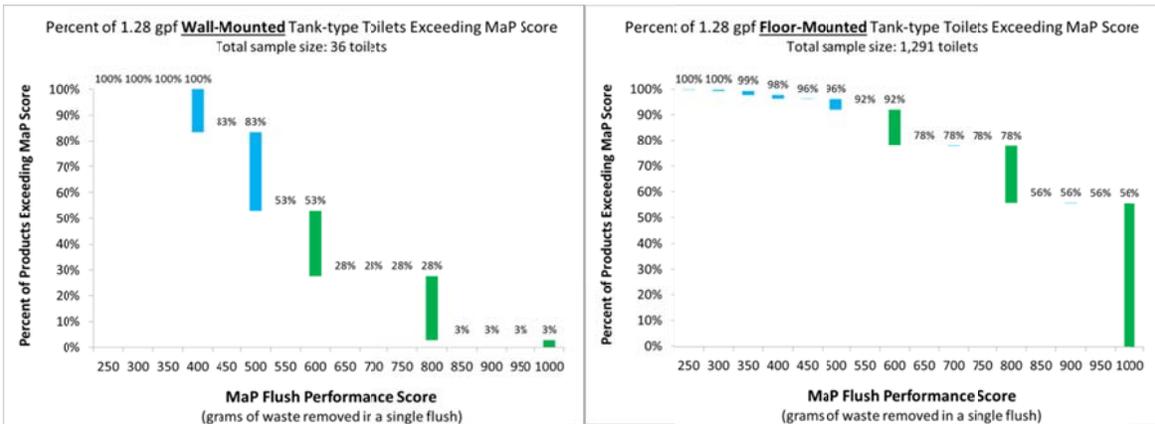
There are many different types of tank-type toilets. The MaP database identifies a number of toilet attributes, and the IOU C&S Team has evaluated this data to verify that toilets with various attributes are able to meet the proposed 600 gram threshold. As shown in Table 3, more than half of the products in each attribute class meet or exceed the 600 gram threshold. For example, 91 percent of the gravity-fed toilets with a MaP rating have a MaP score of 600 grams or higher.

**Table 3: Percent of 1.28 gpf Tank-type Toilets with Various Attributes that Meet or Exceed 600 gram Threshold**

Toilet Attribute		Percent of Products with MaP Score Equal to or Greater Than 600 grams
Type of Toilet	Gravity-fed	91%
	Power-assist	93%
	Gravity-fed with a vacuum assist	87%
Flush Type	Dual-Flush	84%
	Single-Flush	94%
Toilet Outlet	Rear	69%
	Standard / Blank	92%
Bowl Shape	Elongated	91%
	Round	93%
	Special bowl design	57%
Flush Valve-Flapper Size	2 inches	84%
	2.5 inches	76%
	3 inches	95%
	4 inches	100%
ADA Toilet	ADA compliant	93%
Mounting	Floor-mounted	92%
	Wall-mounted	53%

A stakeholder expressed concern that wall-mounted toilets may have difficulty complying with the 600 gram threshold. Most wall-mounted toilets are flushometer toilets. However, 4 percent of the tank-type toilets in the MaP database use 1.28 gpf or less are wall-mounted. As shown in Figure 3, 53 percent of the wall-mounted tank-type toilets that have received a MaP score other than NM already meet or exceed the proposed 600 gram threshold.

Figure 3 also shows that of the 1,291 floor-mounted tank-type toilets that use 1.28 gpf or less and that received a MaP score other than NM, 92 percent already meet or exceed the 600 gram threshold.



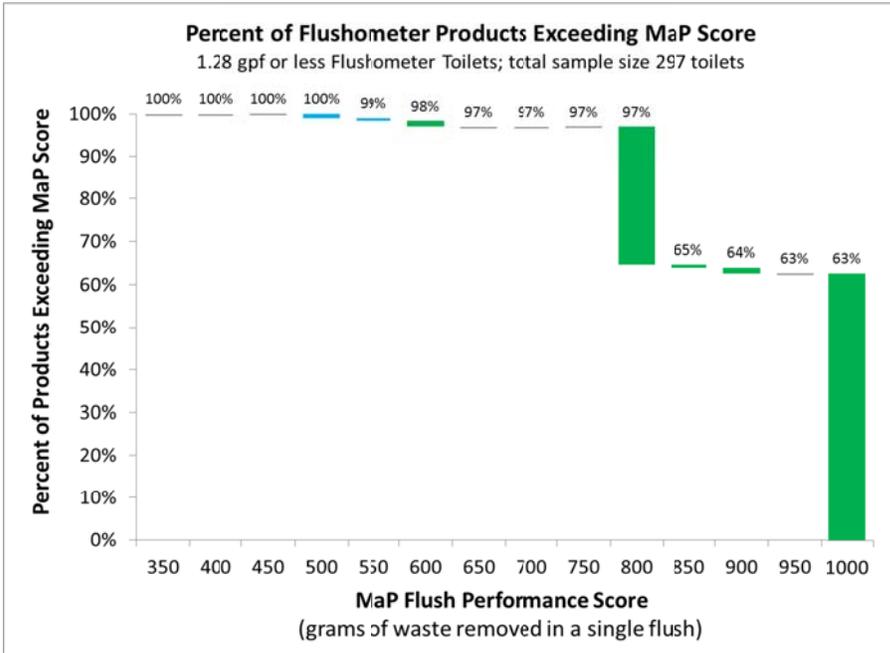
**Figure 3: 1.28 gpf or More Efficient Floor-mounted and Wall-mounted Tank-Type Toilets that Meet or Exceed Various MaP Scores**

Source: MaP Database; Tank-type toilets; December 27, 2013.

**Performance of Flushometer Toilets**

As of November 29, 2013, there were 297 flushometer toilets in the MaP database that consumed 1.28 gpf or less. As shown in Figure 4, there are no products that scored lower than 500 grams. Ninety-eight percent of the listed flushometer products would meet or exceed the 600 gram threshold.

It should be noted that the flushometer toilets were tested using the original MaP test protocol, which was designed for tank-type toilets (residential toilets). MaP is developing a more rigorous test procedure for nonresidential applications, which will be released in early 2014.



**Figure 4: 1.28 gpf Flushometer Toilets that Meet or Exceed Various MaP Scores**

Source: MaP Database; Flushometer toilets; November 29, 2013.

As with tank-type toilets, there are many different types of flushometer toilets. The MaP database identifies a number of toilet attributes, and the IOU C&S Team has evaluated this data to verify that toilets with various attributes are able to meet the proposed 600 gram threshold. As shown in Table 4, more than 95 percent of the products in each attribute class meet or exceed the 600 gram threshold. For example, 99 percent of the wall-mounted units meet or exceed the 600 gram threshold.

**Table 4: Percent of 1.28 gpf Flushometer Toilets with Various Attributes that Meet or Exceed 600 gram Threshold**

Toilet Attribute		Percent of Products with MaP Score Equal to or Greater Than 600 grams
Toilet Outlet	Rear	98%
	Standard / Blank	99%
Bowl Shape	Elongated	98%
	Round	100%
ADA Toilet	ADA compliant	99%
Mounting	Floor-mounted	98%
	Wall-mounted	99%

As mentioned earlier one commenter was inquiring about the ability of wall mounted toilets to meet or exceed the 600 gram MaP score threshold. The data in Table 4 indicates that 99 percent of the wall-mounted flushometer type toilets would meet or exceed the 600 gram rating. In other words, the market impact is negligible.

### *Performance of Children's Toilets*

As of December 19, 2013 there were four children's tank-type water closets from four unique brands that used 1.28 gpf or less in the MaP database. Two had a MaP score of 600 grams, one had a score of 500 grams, and the maximum performance of the fourth toilet was not measured. This indicates that it is possible for children's tank-type toilets to achieve the 600 gram performance metric.

In addition to the four tank-type toilets there were 6 children's flushometer toilets from five brand names that used 1.28 gpf or less. Of the 6 models, 1 was rated at 500 grams, 2 were rated at 800 grams, 2 were rated at 1000 grams, and the maximum performance of the sixth toilet was not measured. Thus 80 percent of rated children's flushometer toilets are meeting or exceeding the 600 gram performance metric.

## MaP Test Procedure does not Sufficiently Account for Impact of Toilet Paper

A 2012 study from the Plumbing Efficiency Research Coalition (PERC) entitled, *The Drainline Transport of Solid Waste in Buildings*, investigated the relationship between toilet flush volume and solid waste transport within building plumbing pipes.<sup>5</sup> One important finding of the study is that toilet paper selection has a significant impact on how effectively waste moves through building pipes. As toilet paper tensile strength increases, waste movement decreases. While the Title 20 standards cannot influence toilet paper selection, this information has implications for the effectiveness of current performance test procedures and the WaterSense performance specification.

Currently, the MaP test protocol requires the use of only "four loosely crumbled balls of toilet paper" with "[e]ach ball of paper... comprised of six sheets of single ply toilet paper."<sup>6</sup> Single-ply toilet paper has low tensile strength and it breaks up relatively easily in water. There are many brands of toilet paper on the market that offer two-ply, three-ply, and even thicker toilet paper designed to be stronger, softer, and more durable than single-ply toilet paper. These thicker types of paper not only breakdown slower they also add to the volume of waste that is flushed. The IOU C&S Team did not conduct a thorough review of the preferred toilet paper for residential applications, but anecdotally the Team encounters two- and three-ply paper more frequently than single-ply toilet paper in residential applications. In addition to concerns about the accuracy of the toilet paper requirements, the MaP protocol does not account for the presence of baby wipes, feminine products, or toilet seat covers (in commercial applications).<sup>7</sup>

Since the test procedure may not be representative of actual toilet events, the IOU C&S Team believes that MaP scores may not fully account for the loads fully experiences in everyday use that includes two or three ply toilet paper. If the test was repeated with two- or three-ply paper instead of single-ply paper, then some of the toilets that previously passed the 350 gram test may not pass. It is outside the scope of the Title 20 standards update to modify the MaP test procedure. CEC can account for the inaccuracies in the test procedure by increasing the allowable MaP threshold. Increasing the previously proposed MaP threshold of 350 to 600 grams will help account for the presence of thicker and stronger toilet paper and other items that are often present in actual solid waste flush events.

## Acceptable Levels for Performance Standards

Mandatory performance standards ensure that products available for sale in California meet a minimum performance threshold to ensure consumer satisfaction. Establishing a performance standard for high efficiency

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<sup>5</sup> Plumbing Efficiency Research Coalition. *The Drainline Transport of Solid Waste in Buildings*. 2012.

<http://www.plumbingefficiencyresearchcoalition.org/wp-content/uploads/2012/12/Drainline-Transport-Study-PhaseOne.pdf>.

<sup>6</sup> Koeller and Company / Gauley Associates Ltd. *Maximum Performance (MaP) Testing Toilet Fixture Performance Testing Protocol Version 5 – March 2013*. [http://www.map-testing.com/assets/files/MaP\\_Test\\_Protocol-Version\\_5-March%202013.pdf](http://www.map-testing.com/assets/files/MaP_Test_Protocol-Version_5-March%202013.pdf).

<sup>7</sup> MaP is developing a test procedure for commercial applications in which it plans to account for the impact of paper toilet seat covers. The commercial test procedure is schedule to be released in early 2014.

toilets (1.28 gpf or less) addresses the potential tradeoffs between efficiency and quality. In other words, a product that is efficient need not be a poor performer.

It is important for CEC to carefully consider what the acceptable minimum performance standard is for all toilets. If the desire is to establish effective water efficiency standards at an acceptable performance level, it is important that CEC considers consumer satisfaction in addition to water savings. As previously described, poor toilet performance could result in a backlash against the water efficiency standard and may hinder toilet replacement due to low consumer confidence that efficient toilets will be capable of providing adequate amenity. Ensuring an acceptable level of quality for toilet performance, such as 600 grams per flush, builds consumer satisfaction with high-efficiency products and has the added benefit of water savings associated with avoiding double-flushing.

The 350 gram performance standard was considered as a backstop to prevent the toilets that perform the poorest from entering the market and to prevent double-flushing most of the time. As evidenced by the MaP data presented above, most toilets exceed the 350 gram standard. Increasing the MaP score to 600 grams would effectively send the message that a toilet has to be better than just being capable of removing *most* waste loads. Rather, the toilet has to be capable of working effectively for all members of the public and not have regular failures. In contrast toilets with only a 350 gram MaP score can be expected to fail twice per month for approximately 20 percent of adult males.

## More Stringent Performance Standard will Result in Water Savings

Ensuring that toilets perform well helps build consumer satisfaction with high-efficiency products and has the side benefit of water savings associated with minimizing double-flushing. Double flushing is the act of having to flush twice to remove waste from a toilet that was unable to clear the waste on the first flush. As shown in Table 5, if all toilets in California minimally met the 350 gram MaP standard, approximately 125 million gallons of water per year would be wasted due to double flushing.

**Table 5: Estimated Water Use from Double-flushing Solid Waste over 350 Grams**

Factor	Value	Variable	Equation or Data Source
California population (people)	38,332,521	A	US Census Data, 2013 estimate
Average stool frequency (hours)	27.4	B	See Table 1
Annual solid waste flushes per person (flushes per person per year)	319.2	C	8760 hrs per year ÷ B
Solid waste flushes over 350 grams (%)	0.8%	D	See Table 1
Solid waste flushes over 350 grams per year (flushes over 350 grams)	97,898,800	F	$A \times C \times D$
Water used per flush (gallons per flush)	1.28	G	
Annual water used for double-flush solid waste over 350 grams, statewide (gallons)	125,310,464	H	$F \times G$

# Impact of More Stringent Performance Standard on Manufacturers and Consumers

## Increasing MaP Threshold Will Not Have a Negative Impact on Manufacturers

A majority of toilets that use 1.28 gpf or less on the market already meet the proposed 600 gram threshold. The following sections explain that qualifying tank-type and flushometer toilets are available from a variety of manufacturers. Given that most manufacturers already sell products that meet the proposed 600 gram threshold, the IOU C&S Team thinks that increasing the threshold is an achievable standard in terms of product availability. While some manufacturers may oppose the more stringent standard because some of their lower performing products could not be sold in California, it is possible that some manufacturers will embrace the standard; lower-performing products would be eliminated and required performance labeling would assist them in differentiating their high performing products. Further, since testing would begin at 600 grams instead of 350 grams, the number of MaP tests will be reduced, thereby reducing the test burden (and likely the cost of testing) for manufacturers of most products. Currently, the MaP test procedure tests flushing performance at the 350, 400, 500, 600, 800, and 1000 gram levels; this proposal would reduce the number of tests in half by requiring tests to failure for 600, 800 and 1,000 gram levels. In other words, setting a MaP threshold of 600 grams is expected to reduce test burden on most manufacturers.

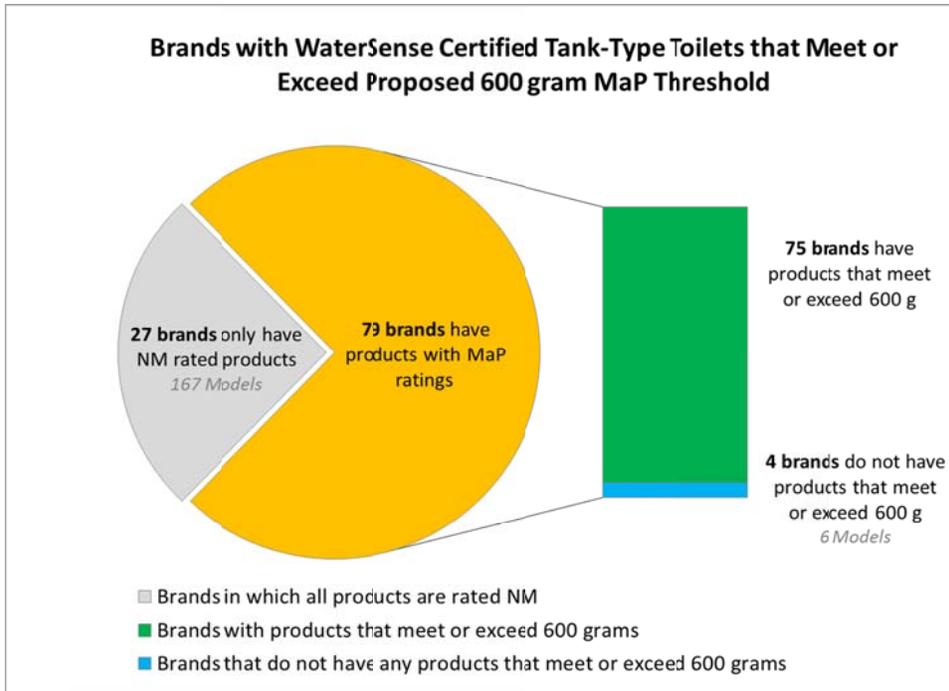
### *Brands that offer WaterSense Certified Tank-Type Toilets*

Overall, there are 106 brands that offer WaterSense certified tank-type toilets (i.e. toilets that use 1.28 gpf or less, meet or exceed the 350 gram MaP threshold, and meet other WaterSense criteria). Twenty-seven of these brands chose to test their products only to the WaterSense minimum level of 350 grams as opposed to testing until failure to determine the maximum performance. Models from these brands received a “NM listing instead of an actual MaP score (see Figure 5). Of the 79 WaterSense brands that have MaP ratings, 75 brands (or 95 percent) already have products that meet the proposed 600 gram MaP rating threshold. Only 4 of the MaP brands do not currently have products that are rated at 600 grams or higher.<sup>8</sup> None of these four brands are major players in the field. In fact, these four brands only offer 6 unique models.

It should also be noted that both siphoning and blowout toilets are among the products that meet or exceed the 600 gram threshold. This implies that it is technically feasible to design a toilet that meets the 600 gram performance threshold using the two standard types of toilet designs available. Brands that do not currently have products that meet or exceed 600 grams have the opportunity to employ proven technology to design products to meet the performance standard.

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<sup>8</sup> The 4 brands with WaterSense certified tank-type toilets that do not meet the 600 gram performance threshold include: Johnson Suisse, Tangshan Leinuo Ceramics, Winfeild, and Xinle Bathroom Products (MaP Maximum Performance database for tank-type toilets, December 27, 2013).



**Figure 5: Brands with WaterSense Certified Tank-Type Toilets that Meet or Exceed 600 gram Threshold**

***Brands that Offer 1.28 gpf Flushometer Toilets***

MaP has tested flushometer bowls from 16 brands and flushometer valves from 4 brands. Products from these bowl and valve brands have been combined to form 25 unique bowl brand / valve brand combinations. Every combination has at least one tested bowl/valve combination that meets or exceeds the 600 gram performance threshold. This indicates that the major bowl and valve manufacturers have products available that can meet the 600 gram threshold. Bowls and valves from various brands can be combined, as they often are, to meet the proposed standard. Given the availability of product from multiple brands, manufacturers should be capable of meeting the 600 gram standard without modifying their product offerings.

***Brands that Offer 1.28 gpf Tank-type and Flushometer Children’s Toilets***

Children’s 1.28 gpf tank-type toilets are available from four brands. Two of the four brands offer toilets that meet the 600 gram threshold.

Children’s 1.28 gpf flushometer toilets are available from five brands. Three of these brands offer toilets that meet the 600 gram threshold.

**Increasing MaP Threshold Not Expected to Have Negative Impact on Consumers**

Setting a performance standard of 600 grams ensures that toilets will be capable of removing all bowl contents (i.e. waste plus toilet paper, seat covers, etc.) in a single flush. Further, a higher performance standard safeguards consumers from purchasing poor performing products.

The IOU C&S Team researched how price varied based on MaP score. Amongst the major toilet manufacturers, there was no notable difference in price between 350 gram and 600 gram toilets.

# Addressing Concerns about More Stringent Performance Standard

## Toilets that Use Less than 1.28 gpf Can Meet 600 Gram Performance Standard

One concern that was raised when considering an increased threshold is that it may be difficult for toilets that use less than 1.28 gpf to meet the 600 gram threshold. MaP has assembled a list of “MaP Premium” toilets. These residential tank-type toilets must have a maximum effective flush volume of 1.06 gpf and meet the 600 gram performance standard. As of December 2013, there were 104 MaP Premium toilets. Thirty-one are gravity-fed single-flush toilets, 31 are gravity-fed dual-flush, and the remaining 42 are pressure-assist single-flush.<sup>9</sup> These products offer both quality performance and high efficiency to address consumer satisfaction and California’s water saving goals. These products offer a glimpse of the next-generation toilets and demonstrate that it is possible to reduce water use below 1.28 gpf while maintaining performance of 600 grams or better. This illustrates that there is still room for further gains in water efficiency while maintaining performance; thus the proposed 600 gram MaP performance metric does not create a barrier for the State to consider more stringent water efficiency standards in the future..

## The Proposed Standard Builds upon WaterSense Criteria

Stakeholders have expressed interest in establishing a California standard that is consistent with the WaterSense specifications. The WaterSense specification for tank-type toilets was established in 2007. The WaterSense performance standards for tank-type toilets have not been updated since the tank-type toilet specification was developed in 2007. The IOU C&S Team understands the desire to have harmony between the WaterSense and California standards. However, California has the opportunity to adopt a standard based on the most recent market data.

The current WaterSense criteria for tank-type toilets include requirements for the durability of flush valves, flush volumes no greater than 1.28 gpf and using the MaP testing procedure to assure that toilets can flush at least 350 grams. This effort has had great impacts on the market and has provided the incentives for manufacturers to adopt MaP testing and to provide a wide range of toilet modes that are meeting or exceeding the WaterSense criteria.

The proposed Title 20 standard, would use the same MaP testing method, but cut the required test weight intervals at least in half (because the minimum allowed MaP score is increased). In addition, these standards prepare the market for a future time when the MaP Premium standard (maximum flush volume of 1.08 gpf and 600 gram minimum MaP score) is the eventual California minimum legal standard. Over 90 percent of WaterSense models and 95 percent of WaterSense brands with rated MaP scores meet the proposed criteria of a maximum 1.28 gpf and minimum 600 gram MaP score. It is not surprising that the State of California, with urgent water conservation needs, might select a slightly more stringent performance requirement than the national WaterSense voluntary program. This minimum MaP score provides users with the confidence to replace their wasteful old toilets and to prevent the added water waste resulting from double flushing.

## Compliance Determination

### Waste Extraction Performance Labeling Requirement

Labeling requirements can help consumers make education decisions about the products they are purchasing. The IOU C&S Team recommends including a waste extraction labeling requirement for toilets to help serve as a

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<sup>9</sup> Maximum Performance (MaP) of "PREMIUM" toilet models. December 5, 2013. [http://www.map-testing.com/assets/files/2013-12-05-map\\_premium-hets.pdf](http://www.map-testing.com/assets/files/2013-12-05-map_premium-hets.pdf).

consumer guide for compliance and purchasing decisions. Due to preemption, Federal labeling requirements must be used to denote the water consumption rating. There are no federal standards for toilet waste extraction performance, nor are there federal labeling requirements or waste extraction performance. California's waste extraction labeling requirements would be in addition to the Federal water consumption labeling requirements. The IOU Team recommends that the label clearly state the toilet's rated waste extraction score in addition to indicating that the toilet meets the Title 20 requirements. Thus for Title 20 compliant toilets, a NM MaP rating would not be sufficient.

## Complete MaP Test at 600, 800 and 1000 grams

Section 2.6.8 of the MaP Testing Toilet Fixture Performance Testing Protocol Version 5 stipulates that mass loading shall begin at 350 grams and the test should be repeated until maximum loading has been reached (as defined). The MaP Protocol clarifies that testing be completed at the following increments: 350, 400, 500, 600, 800, and 1000 grams. To reduce the testing burden and associated cost, the IOU C&S Team recommends that flush performance testing commence at 600 grams and continue until waste extraction failure at the following increments: 600, 800, and 1000 grams. This eliminates three of the waste extraction tests required to obtain a California approved MaP score.

## Require MaP Score in Data Submittal Requirements

In the CASE Report submitted in July 2013, the IOU C&S Team recommended that the MaP score be included in the Data Submittal Requirements to verify compliance with the Title 20 standards. As noted in this addendum, many products listed in the MaP database have received a NM score. Currently, a product can receive WaterSense certification by verifying that it can meet the 350 gram threshold, but without testing the toilet to failure to identify the maximum performance. It is recommended that the CEC require an actual MaP score as opposed to verification that the product is capable of meeting the minimum threshold limit. Collecting accurate information about toilet performance will enable the CEC to assemble valuable information about the performance of products currently available for sale in California. This data could be helpful when evaluating code changes in the future. In addition this MaP score should be required on the product packaging. This gives the consumer performance information at time of purchase.

## Recommended Code Language

The recommended code change language is provided below. Modifications to the language presented in the CASE Report are highlighted in blue and identified with ~~double strikeout~~ or double underlining. The recommended change to the standard for blowout water closet is detailed in a document the IOU C&S Team provided the CEC in October 2013. Modifications to the test procedure are recommended because the recently issued revised federal test procedure addresses concerns about static pressure requirements and trim component adjustments.<sup>10</sup>

### Section 1604. Test Methods for Specific Appliances.

#### (i) Plumbing Fixtures.

(1) The test methods for plumbing fixtures are as follows: ~~is ANSI/ASME A112.19.6-1995~~

- (A) 10 CFR Section 430.23(t) (Appendix T to Subpart B) ~~ASME A112.19.2-2008/CSA B45.1-08;~~  
and

<sup>10</sup> DOE issued a Final Rule on October 23, 2013 (78 FR 62967).

(B) MaP Testing Toilet Fixture Performance Testing Protocol Version 5 – March 2013 with testing required at the following intervals: 600 grams, 800 grams, and 1000 grams.

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The following documents are incorporated by reference in Section 1604.

**AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)**

ANSI/ASME A112.19.6-1995 — Hydraulic Performance Requirements for Water Closets and Urinals

ASME A112.19.2-2008 — Ceramic Plumbing Fixtures

**MAXIMUM PERFORMANCE (MAP) TESTING**

MaP Testing Toilet Fixture Performance Testing Protocol Version 5 – March 2013

**Section 1605.2. State Standards for Federally-Regulated Appliances.**

**(i) Plumbing Fixtures.**

(1) The water consumption of water closets and urinals shall not greater than the values shown in Table I-1.

**Table I-1.**

**Standards for Water Closets and Urinals**

<i>Appliance</i>	<i>Maximum Gallons per Flush</i>
<u>Blowout water closets</u>	<u>3.5</u>
Dual-flush water closet (full-volume flush)	1.28
Other water closets	1.28
Trough-type urinals	<u>Trough length (inches)</u>
	16
Blowout urinals	1.0
Floor-mounted urinals	0.5
Other urinals	0.125

(2) Water closets shall achieve a MaP score of no less than 350 600 grams.

See Section 1605.1(i) for water efficiency standards for plumbing fixtures that are federally-regulated consumer products.

(3) Water closets and urinals shall be marked and labeled as follows:

(A) Each water closet (and each component of the water closet if the fixture is comprised of two or more components) and urinal shall be marked in accordance to 16 C.F.R. 305.16 (b)

(B) The package, shall be clearly, legibly, and permanently labeled, in at least 12 point type and in a place likely to be seen by the purchaser with the maximum solid waste extraction performance (MaP score) expressed in grams.

**Section 1606. Filing by Manufacturers; Listing of Appliances in Database.**

**Table X - Data Submittal Requirements**

<i>Appliance</i>	<i>Required Information</i>	<i>Permissible Answer</i>
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I	Plumbing Fixtures	*Type	Blowout water closet, <u>dual-flush water closet</u> , gravity <u>flush tank type</u> water closet, <u>electromechanical</u> -hydraulic water closet, flushometer tank water closet, prison-type water closet, flushometer valve water closet, vacuum-type water closet, urinal, <u>floor-mounted urinal</u> , <u>non-water-consuming</u> <del>waterless</del> urinal, prison-type urinal, trough-type urinal, vacuum-type urinal, <u>replacement urinal valve</u> , <u>replacement water closet valve</u>
		Water Consumption ( <u>full-flush volume for dual-flush water closets</u> )	
		<u>Reduced flush-volume Water Consumption (dual-flush water closets only)</u>	
		<u>MaP Score</u>	
		<u>Location of marking or labeling</u>	<u>Packaging, Product</u>
		Trough Length (trough-type urinals only)	

## Conclusion

The IOU C&S Team recommends establishing a performance standard for all toilets that would require toilets to flush at least 600 grams of waste on the first flush, as tested according to the MaP test procedure. To reduce the testing burden, the test only must be conducted at three intervals (i.e., 600, 800, and 1000 grams) per model. The IOU C&S Team recommends establishing a package labeling requirement that identifies the maximum waste extraction (MaP) score. This will help consumers make informed purchasing decisions. Finally, the IOU Team reiterates the recommendation made in the CASE Report that manufacturers be required to submit the MaP score of each qualifying model as part of their data submittal requirements.

To establish sustainable standards that ensure that the desired amenity is preserved, it is important for CEC to provide for consumer protection in addition to water conservation. A failure to provide an adequate level of consumer protection could result in a backlash against the standards and could hinder toilet replacement due to low consumer confidence in efficient toilets for fear of poor waste removal performance.

If CEC adopts a MaP threshold of 600 grams, all toilets will be required to not only remove *most* loads (350 grams), but they will be required to remove *all regularly expected* loads. As previously discussed in this addendum, the waste extraction loads for men in the short controlled study referenced by WaterSense would exceed 350 grams by 20 percent of the men approximately once every two weeks. In addition, the measured 350 grams does not include an accurate representation of the type of toilet paper or other common items that are often present in flushing events.

As the market data indicate, over 90 percent of the 1.28 gpf toilets that are currently available on the market already meet or exceed the 600 gram threshold. It is technically feasible to design, manufacture, and sell toilets at the proposed performance level for reasonable price. In fact, market data suggest that toilet performance is already moving towards higher MaP scores. While some manufacturers may oppose the more stringent standard

because some of their lower performing products will not be sold in California, it is possible that some industry players will embrace the standard, as they will not have to compete against lower-performing products.

Consumers only stand to gain from a more stringent performance standard as it safeguards them against purchasing poor performing products. The higher performance standard is also not expected to impact the cost of toilets. In an Internet review of toilet prices for a large toilet retailer, the least expensive toilets had 1,000 gram MaP scores.

Setting the performance standard at 600 grams as opposed to 350 grams will lead to a lower incidence of waste remaining in the bowl after solid waste flushes, water savings due to fewer double-flush events, and improved consumer satisfaction. Toilets that meet the proposed 600 gram threshold are already widely available at no additional cost. Given this evidence, the IOU C&S Team urges the CEC to adopt a performance standard of 600 grams for all toilets, along with manufacture submission of MaP scores, and a labeling requirement for all qualifying toilets.