



U.S. PRESIDENT'S MALARIA INITIATIVE



THE PMI VECTORLINK PROJECT ZAMBIA

2019 END OF SPRAY REPORT

SPRAY CAMPAIGN: OCTOBER 2-NOVEMBER 30, 2019

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ACRONYMS

AIRS	Africa Indoor Residual Spraying Project
BMP	Best Management Practices
DCV	Data Collection Verification form
DDT	Dichlorodiphenyltrichloroethane
DEC	Data Entry Clerk
DHIS2	District Health Information System 2
DHO	District Health Office
ECO	Environmental Compliance Officer
EHT	Environmental Health Technician
GRZ	Government of the Republic of Zambia
HFCA	Health Facility Catchment Area
HLC	Human Landing Catch
IEC	Information, Education, and Communication
IRS	Indoor Residual Spraying
ITN	Insecticide-treated net
M&E	Monitoring and Evaluation
MOH	Ministry of Health
MSP	Mobile Soak Pit
NHC	Neighborhood Health Committee
NGenIRS	Next Generation IRS
NMEP	National Malaria Elimination Program
PSC	Pyrethrum Spray Catch
PSECA	Pre-Season Environmental Compliance Assessment
PHO	Provincial Health Office
PMI	President's Malaria Initiative
PMT	Performance Monitoring Tracker
PPE	Personal Protective Equipment
PSI	Population Services International
SBCC	Social Behavior Change Communication
SOP	Spray Operator
TDRC	Tropical Disease Research Center
TOT	Training of Trainers
TLA	Team Leader Assistant
TWG	Technical Working Group
USAID	United States Agency for International Development
UTH	University Teaching Hospital
WHO	World Health Organization
ZEMA	Zambia Environmental Management Agency

EXECUTIVE SUMMARY

The U.S. President’s Malaria Initiative (PMI) VectorLink Project, funded by the U.S. Agency for International Development (USAID) and implemented by Abt Associates, has supported the implementation of indoor residual spraying (IRS) in Zambia since 2006.

VectorLink Zambia conducted its 2019 IRS campaign from October 2 to November 30, 2019. The project aimed to spray a total of 617,000 structures (later adjusted to 597,625). This included a target of 500,000 structures in 17 target districts—six districts in Eastern Province, 10 districts in Copperbelt Province (rural and peri-urban areas), and one district (Nchelenge) in Luapula Province, later adjusted to 480,625 structures. The project also targeted 117,000 structures in the three pre-elimination districts of Eastern Province (Katete, Sinda, and Chadiza). The project sprayed SumiShield 50WG (the neonicotinoid, clothianidin) in Eastern Province, and Fludora Fusion (clothianidin and deltamethrin) in Copperbelt and Nchelenge District.

Project achievements during the 2019 spray campaign included:

- Sprayed 536,983 structures out of 598,732 structures found by spray operators (SOPs), resulting in 90% spray coverage. Protected 2,273,188 people, including 318,396 children under 5 and 50,100 pregnant women.
- Trained 2,120 individuals to deliver IRS in 20 districts. Of these, 171 were supervisors, 1,524 were SOPs, 319 were team leaders, and 106 were team leader assistants. Females accounted for 33% of all staff trained to deliver IRS and 25% of supervisory positions.
- Used 104,749 sachets of SumiShield to spray 383,183 structures in Eastern Province (3.7 structures per sachet) and 46,535 sachets of Fludora Fusion to spray 122,708 structures in Copperbelt Province and 31,092 structures in Nchelenge District (3.3 structures per sachet).
- Conducted wall bioassays within 24–48 hours of spraying and recorded 100% mortality of susceptible *An. gambiae* (Kisumu strain) on all wall surface types sprayed with both insecticides, signifying a high-quality spray.

The project will dispose of all IRS wastes (empty insecticide sachets, nose masks, damaged gloves, boots, and assorted plastic items) according to PMI best management practices.

I. COUNTRY BACKGROUND

The United States Agency for International Development (USAID) began funding indoor residual spraying (IRS) activities in Zambia in 2006. In 2008, the U.S. President's Malaria Initiative (PMI) started supporting IRS in Zambia, covering 15 districts across four provinces. In 2011, following delays in World Bank funding for district IRS operations, PMI bridged the gap and funded IRS in 25 high-malaria burden districts. From 2012 to 2013, PMI focused its support in 20 districts in three provinces with the highest malaria incidence, targeting an estimated 530,000 structures (13 districts in Northern and Muchinga Provinces which were sprayed with bendiocarb and seven districts sprayed with Actellic). However, due to limited resources, the 13 districts did not receive the second spray round of bendiocarb as planned.

The country switched to targeted spraying in 2014 to prioritize coverage of high-risk areas in 40 high-burden malaria districts, in line with Zambia's 2011–2016 National Malaria Strategic Plan. These 40 districts included 15 districts in Luapula and Central Provinces and was funded by the United Kingdom's Department for International Development. From 2016-2019, PMI IRS programs in Zambia benefited from Next Generation IRS (NGenIRS)/Unitaid co-funding, allowing the project to support IRS in 35 districts across Eastern, Luapula, Muchinga, and Northern Provinces.

In 2017, the government officially launched the National Malaria Elimination Strategic Plan 2017–2021, which aims to transition Zambia from malaria control to malaria elimination. In the same year, PMI, AIRS Zambia, and the Zambia Ministry of Health (MOH) agreed to continue IRS in the same 36 high-burden districts across Eastern, Luapula, Muchinga, and Northern Provinces (one district, Mbala, was split into two, which brought the total to 36 districts in 2017). In the 2017 campaign, AIRS Zambia sprayed 634,410 structures out of 676,188 structures found. In 2018, PMI VectorLink, together with Zambia's National Malaria Elimination Program (NMEP), supported IRS in Northern, Luapula and Muchinga Provinces and three pre-elimination districts (Chadiza, Katete, and Sinda) in Eastern Province. In 2018, VectorLink sprayed 579,490 structures out of 644,677 structures found. Table 1 provides a summary of USAID and PMI support for IRS in Zambia from 2006 to 2019. It is important to note that malaria burden in Zambia follows a pattern that is influenced by rainfall, temperature, and other environmental factors. The burden is lowest from June to August when the temperatures are low (average of 5⁰C) and highest from November to April when it is wet and the temperatures are high (average of 30⁰C). Because of this, timing of IRS is planned as close to the rainy season as possible before the proliferation of mosquito breeding sites due to the rains.

Table 1: USAID and PMI Support for IRS in Zambia, 2006 to 2019

Year	# of Structures Sprayed	# of Persons Protected	# of USAID Supported Districts	# of PMI Supported Districts	Insecticide Used
2006	537,877	—	15	—	DDT and pyrethroids
2007	657,219	—	15	—	DDT and pyrethroids
2008	1,039,154	—	36	3	DDT and pyrethroids
2009	1,191,517	—	—	36	DDT and pyrethroids
2010	740,699	2,721,166	—	25	DDT and pyrethroids
2011	814,706	3,351,158	—	35	Carbamates and pyrethroids
2012	460,358	1,710,833	—	20	Carbamates and organophosphates
2013	432,398	1,842,821	—	20	Organophosphates
2014	409,544*	2,000,824	—	40	Organophosphates
2015	519,598*	2,544,290	—	39	Organophosphates
2016	559,550	2,626,718	—	35	Organophosphates
2017	634,410	3,005,878	—	36	Organophosphates
2018	491,873	2,504,775	—	26	Organophosphates
	87,617	313,401	—	3	Neonicotinoids (SumiShield)
	Total 579,490	2,818,176	—	29	Organophosphates and Neonicotinoids
2019	383,183	1,519,927	—	9	Neonicotinoids (SumiShield)
	153,800	753,261	—	11	Neonicotinoids (Fludora Fusion)
	Total 536,983	2,273,188	—	20	Neonicotinoids (SumiShield and Fludora Fusion)

*Includes PMI and DFID funded areas.

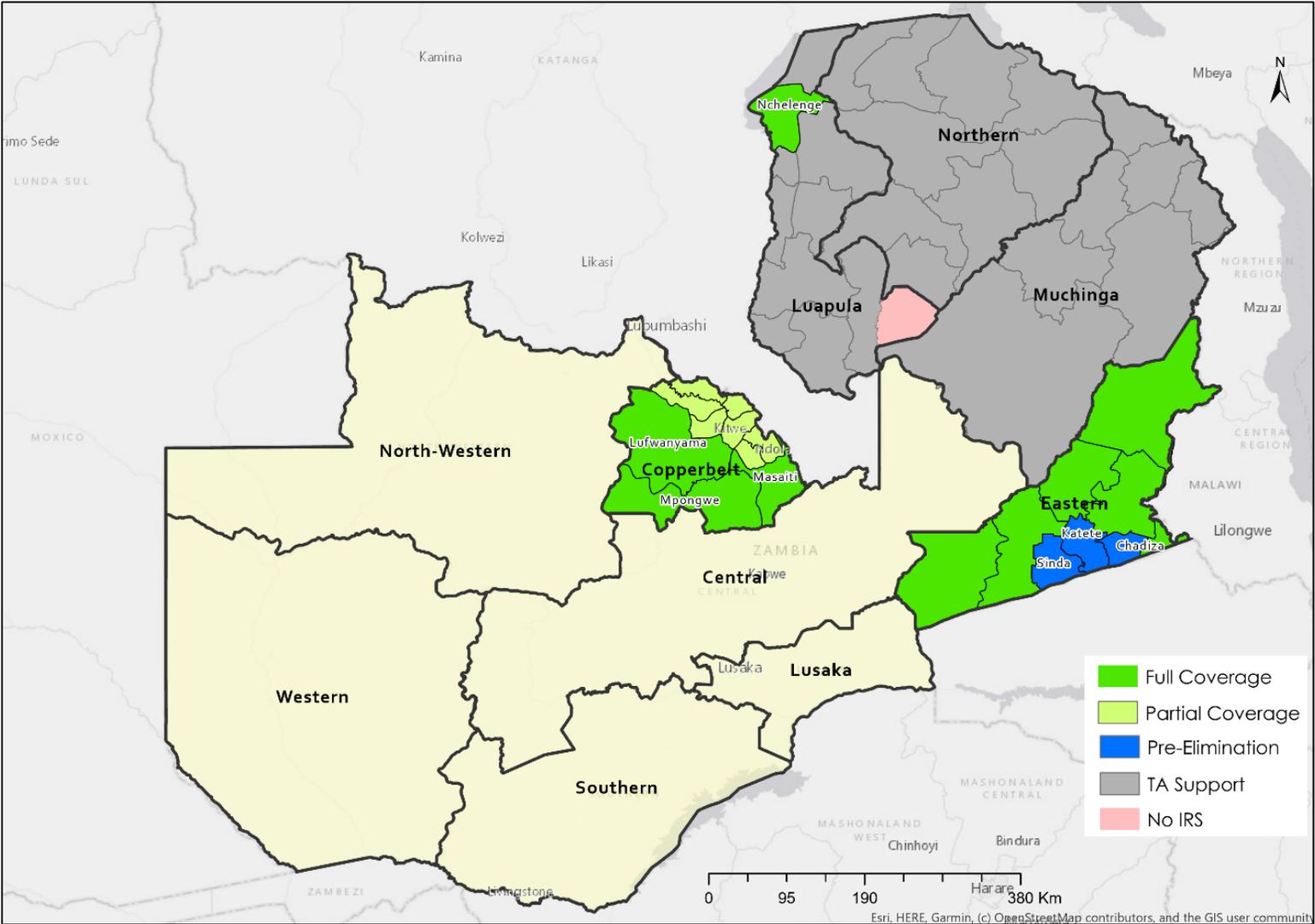
In 2019, the NMEP planned to spray all structures in Northern, Luapula (excluding Nchelenge district), and Muchinga Provinces with dichlorodiphenyltrichloroethane (DDT). The NMEP, together with PMI, therefore agreed to shift VectorLink's focus to both Eastern and Copperbelt Provinces, plus Nchelenge district in Luapula Province. The project's initial target was 617,000 structures in 20 districts—117,000 structures in three districts in Eastern Province (Katete, Sinda, and Chadiza) using supplemental pre-elimination funds, and 500,000 structures across 10 districts in Copperbelt Province, Nchelenge district, and the remaining six districts in Eastern. More specifically in Copperbelt, the project aimed for full coverage of three rural districts¹ (Lufwanyama, Masaiti, and Mpongwe), and targeted only the rural and peri-urban areas of the remaining seven urban districts.

VectorLink's overall target was adjusted during the campaign to 597,625 structures to remove areas included in the WHO-funded AFROII vector control study taking place in Nyimba district², the removal of four health facility catchment areas (HFCAs) in Copperbelt, and the removal of ineligible structures from the Nchelenge target. As in the previous two years, the project benefited from the NGenIRS project which included a co-payment for insecticide procurement.

¹According to the Central Statistics Office, a rural district is one that lacks most (if not all) the facilities/amenities found in the urban areas. The population tends to be scattered. An urban district on the other hand is one that incorporates elements of population density, social and economic organization, and the transformation of the natural environment into a built environment.

²The study aims to evaluate the impact of screening in reducing the number of mosquitoes entering houses.

Figure 1: PMI VectorLink-Supported IRS Provinces and Districts in 2019



2. IMPLEMENTATION OF IRS ACTIVITIES

The following sections describe activities and results before, during, and after the campaign.

2.1 IRS PLANNING AND PARTNER COLLABORATION

In 2019, VectorLink Zambia activities fell under two broad categories: (1) technical assistance to NMEP and MOH on IRS, with an emphasis on the Government of the Republic of Zambia (GRZ) transition to the use of DDT for IRS in the previous PMI IRS supported districts in Luapula, Muchinga, and Northern Province and (2) implementation of IRS and entomological monitoring in the targeted PMI provinces, Refer to Figure 1 in Section 1. VectorLink Zambia provided technical assistance to the NMEP and district health offices (DHOs) in all areas of IRS implementation in the 20 selected districts with the original target of 617,000 structures, which was eventually adjusted to 597,625 structures in the target districts comprising—nine districts in Eastern, 10 in Copperbelt (rural and peri-urban), and one in Luapula.

The 2019 campaign was planned for 30 operational days (October 2 to November 7). However, due to challenges encountered in Copperbelt Province, the campaign ran for 42 operations days (see Section 6 for details). Based on the consultation with the NMEP and Insecticide Resistance Management Technical Working Group and the available entomology data, VectorLink Zambia deployed SumiShield (a clothianidin-based insecticide) in Eastern Province and Fludora Fusion (clothianidin and deltamethrin) in Copperbelt Province and Nchelenge district.

VectorLink Zambia partnered with the NMEP and MOH officers at the central, provincial, and district levels to conduct IRS. Additionally, the project subcontracted international partners Dimagi LLC, Population Services International (PSI), BAO Systems, and PATH. Locally, the project subcontracted Akros to work in eight districts. Other local partners included, Tropical Disease Research Center (TDRC), Zambia Environmental Management Agency (ZEMA), and the University of Zambia, University Teaching Hospital (UTH), mining companies (Konkola and Mopani copper mines) as well as civic, community, and church leaders. Table 2 summarizes the roles of local and international partners.

Table 2: PMI VectorLink Zambia Partners

Partner	Role
International Subcontractors	
Dimagi LLC	Implemented mHealth activities including mobile-based Performance Monitoring Tracker (PMT), smartphone-based spray supervision system, bulk SMS job aids, and data collection verification (DCV) forms.
PSI	Conducted social behavior change communication (SBCC) study in Nchelenge to identify influential determinants to IRS acceptance with a goal of decreasing refusals.
BAO Systems	Worked with Abt staff to update the VectorLink Collect DHIS2 database. Collaborated with VectorLink Monitoring and Evaluation (M&E) and Abt’s Data Science, Surveys, and Enabling Technology staff in the development of the VectorLink Collect entomology module.

Partner	Role
PATH	Provided technical assistance for data review to support vector control decision-making under the PMI VectorLink integrated data analytics and visualization activity. Updated data dashboards with 2018 spray coverage, entomological monitoring, and insecticide resistance monitoring data from GRZ, PMI VectorLink, the Malaria Control and Evaluation Partnership in Africa (MACEPA) project.
Local Subcontractors	
Akros	Supported IRS operations in the three pre-elimination districts in Eastern Province and Nchelenge District through implementation of Reveal, a tool which supports planning, targeting, and recording delivery of IRS activities. Assisted with satellite based enumeration and mapping of Ndola, Kitwe, Chipata, and Petauke districts.
Local Partners	
NMEP/MOH	Functioned as main partner in planning and management, implementation, supervision and monitoring of the program.
ZEMA	Ensured compliance with local Zambia environmental laws.
UTH	Supported environmental compliance through incineration of IRS waste materials.
University of Zambia	Served as strategic partner on the IRS technical working group.
TDRC	Shared entomological and monitoring data to support vector control decision-making, particularly in Nchelenge district in Luapula Province.
Konkola and Mopani Copper Mines	Engaged in joint IRS planning and training with VectorLink. Additionally, Konkola Copper Mines provided training facilities for team leaders and spray operators.
Private sector companies	Served as strategic partners on the IRS technical working group. Specific companies included First Quantum, Indeni Oil Refinery, Zambeef, and Zambia Sugar.
Local and traditional leaders	Helped increase acceptance of IRS in the community.

2.1.1 PRE-SPRAY PLANNING ACTIVITIES

VectorLink worked closely with the NMEP and provincial and district health offices to carry out various pre-spray activities including geographical reconnaissance, structure enumeration, micro-planning meetings, stakeholder advocacy meetings, logistical needs assessments, data center assessments as well as recruitment and training of spray personnel. Since PMI VectorLink supported IRS in Copperbelt Province for the first time this year, geographical reconnaissance was conducted to gather updated information. The project also undertook geographical reconnaissance in four districts in Eastern Province (Petauke, Lundazi, Chipata, and Nyimba) to inform the establishment of new operations sites needed to handle the increased target.

Three months prior to the campaign, VectorLink collaborated with the NMEP to hold a micro-planning meeting in each of the three target provinces. The teams used the meetings to fine-tune training plans and commodity and human resource needs and discuss infrastructure, transportation, and management support for the campaign. Prior to the meeting, districts populated a microplanning template, developed by the project. Districts used the number of structures found during the 2018 spray campaign (for those districts where VectorLink sprayed) and updated/enumerated maps from Akros (for both new and 2018 districts) to determine the number of target structures by catchment area. During the microplanning meetings, these maps (plus input from the districts based on physical count) served as the basis for estimating the final targeted structures. The overall target was then adjusted to match the PMI-approved number of structures to be sprayed as contained in the Malaria Operational Plan for the 2018 fiscal year.

In Copperbelt, where the PMI IRS campaign ran concurrently with the GRZ/Global Fund-supported campaign, the project worked with NMEP and DHOs to select PMI IRS-supported HFCAs based on the disease burden. In Kitwe and Ndola, the initial goal was to use the ecological targeting approach based on the 2017 Akros-led operational research findings from Eastern Province. In a setting of limited PMI resources for peri-urban coverage, the hope was to be able to prioritize among peri-urban HFCAs based on modelling

of vector density. However, the approach was eventually not used as it appeared that Akros still required more time to improve on its applicability. As such, the project in collaboration with NMEP and DHOs selected peri-urban areas based on disease burden. Table 3 shows 2019 targeted HFCAs per district.

Table 3: Targeted Catchment Areas by District

District	HFCAs per District	Targeted HFCAs per District	Total Structures Reported by District ^a	Eligible Structures in District	Eligible Structures in Targeted HFCAs	Eligible Structures in Non-Targeted HFCAs ^b
Eastern	285	279	547,117	451,578	419,291	33,320
Chadiza	21	21	24,052	23,001	22,800	201
Chipata	61	59	162,872	131,662	120,117	11,545
Katete	34	30	47,195	46,373	35,700	11,495
Lundazi	52	52	94,041	76,191	76,191	0
Mambwe	21	21	26,048	22,215	22,215	0
Nyimba	21	21	41,812	24,602	17,909	6,693
Petauke	40	40	81,147	63,333	63,333	0
Sinda	23	23	59,045	53,507	50,332	3,175
Vubwi	12	12	10,905	10,694	10,694	211
Copperbelt	246	113	563,031	560,628	144,449	416,178
Chililabombwe	7	2	29,046	29,046	4,225	24,821
Chingola	16	4	65,469	65,469	8,457	55,513
Kalulushi	21	12	35,067	35,067	12,276	22,791
Kitwe	39	13	165,000	165,000	11,516	153,484
Luanshya	29	6	28,050	28,050	6,705	21,345
Lufwanyama	21	21	24,031	21,628	21,933	1,194
Masaiti	31	16	24,209	24,209	24,209	0
Mpongwe	24	24	37,515	37,515	37,515	0
Mufulira	25	6	44,000	44,000	6,805	37,194
Ndola	33	9	110,644	110,644	10,808	99,836
Luapula	15	13	41,533	38,134	33,885	4,249
Nchelenge	15	13	41,533	38,134	33,885	4,249
Grand Total	546	405	1,151,681	1,050,340	597,625	453,747

^a Districts used head count population data to estimate total eligible structures.

^b Based on discussions with districts and considering the NMEP criteria for IRS, certain HFCAs such as urban areas with very high refusal rates, and areas with scanty and dispersed structures such as farm blocks were not targeted.

2.2 TRAINING

Before spray operations began, VectorLink Zambia collaborated with DHOs to train personnel involved in IRS. Table 4 lists the number of personnel trained in different categories disaggregated by gender and training duration.

Table 4: Number and Type of Full-Time GRZ and Seasonal Workers Trained, by Gender

Category	Duration of Training	Males	Females	Total (% Female)
Supervisors	5 days	128	43	171 (25%)
Mobilizers	1 day	5,983	1,598	7,581 (21%)
SOPs	6 days	995	529	1,524 (35%)
Team leaders	5 days	221	98	319 (31%)
Team leader assistants	5 days	83	23	106 (22%)
Data entry clerks	3 days	35	43	78 (55%)
M&E assistants	2 days	35	10	45 (22%)
Storekeepers	2 days	46	27	73 (37%)
TOTAL		7,526	2,371	9,897 (24%)

2.3 SPRAY OPERATIONS AND SUPERVISION

2.3.1 OPERATIONS

In Zambia, based on the recommendation from the Insecticide Resistance Management Technical Working Group and historical entomologic data, IRS implementation usually starts before the onset of the rainy season in early November. The malaria burden in Zambia follows a pattern that is influenced by rainfall, temperature, and other environmental factors. The burden is lowest from June to August when the temperatures are low (average of 5°C) and highest from November to April when it is wet and the temperatures are high (average of 30°C). The timing of IRS is therefore planned as close to the rainy season as possible before the proliferation of mosquito breeding sites due to the rains. It is recommended that insecticides with adequate residual efficacy are deployed to cover most of the malaria transmission period, which generally extends into April except in swampy areas in Luapula, such as Nchelenge district, where transmission has been documented to extend into September and October.

In 2019, the PMI VectorLink-supported spray campaign started on Wednesday, October 2 and was scheduled to end on Thursday, November 7. However, due to the unexpected declaration of October 25 as a national holiday, eight of the nine districts in Eastern Province concluded the campaign by November 9; Chadiza ended on November 11 after a one-day extension. The campaign in Nchelenge was also extended by six days to ensure adequate mop-up of target structures and ended on November 15. In Copperbelt, after a week-long hiatus (October 28–November 2) and the addition of several operational days, the campaign ended on November 30, 2019. Table 5 indicates campaign start and end dates for each district. To deliver IRS, the project implemented three IRS technical approaches for spray team deployment: 1) Centralized or district-based which involved spray teams departing from a centrally located operations site to spray areas in vehicles; 2) Community-based which involved use of bicycles for the entire duration of the spray campaign and; 3) Quasi-community-based which involved use of bicycles within 10km radius from the operations sites during the last four days. The project implemented a centralized IRS technique in 18 districts, quasi-community-based IRS in one district (Lundazi) and community-based IRS in another district (Petauke) (refer to Section 2.9 for details).

Copperbelt Province

Copperbelt Province reported low progress and coverage after 19 operational days which led to a weeklong pause of IRS operations, from October 28 to November 2, 2019. During this period, the VectorLink team

met with PMI, the NMEP, Copperbelt Provincial Health Office (PHO), and DHOs to discuss and resolve the challenges that resulted in recording low spray progress and coverage. Additionally, the team retrained IRS managers, supervisors, team leaders, and health promotion officers on effective IRS supervision, with a focus on improved deployment of spray teams, household preparation, and revised mobilization strategies. Other key areas of emphasis were on intensifying mop-up visits, and recording all found structures appropriately, particularly during mop-up visits. As part of the resolutions and to ensure effective IRS implementation when the campaign resumed, the team consulted with the NMEP and PMI and made the following changes:

- Embedded two mobilizers drawn from Neighborhood Health Committees (NHCs) per spray team to assist with household preparation.
- Reduced the daily SOP target from 15 to 13 structures.
- Excised four HFCAs (total of 8,567 structures) in the least performing urbanized districts from the targeted spray areas: Kakoso (2,255) and Kasumbalesa (1,257) in Chililabombwe, and Allesandras (2,088) and Fisenge (2,967) in Luanshya.
- Extended the spray campaign by three days in the seven urbanized districts and by 12 days in Lufwanyama, 11 days in Masaiti, and four days in Mpongwe to ensure 85% spray progress. Consistent with PMI technical guidance, the team prioritized reaching targets in the three high-burden rural districts.
- Intensified supervision of IRS operations at all levels by assigning one VectorLink staff to each operations site. To reinforce VectorLink supervision personnel, a few district coordinators from Eastern Province (where the campaign ended November 9) joined the Copperbelt supervisory team.

The campaign resumed on November 4 in all districts except Luanshya, which lagged the most in progress/coverage. The district delayed resumption by an additional week (given November 4 marked the start of Child Health Week), and used the time to intensify community sensitization and mobilization and improve acceptance of IRS upon continuation of the campaign on November 11. However, upon resumption, Luanshya continued to record low spray coverage due to refusals in peri-urban HFCAs, which in some cases (Franco HFCA) seem to qualify as urban. Though the team continued to engage both influential leaders and NHCs to help increase acceptance of IRS during mop-ups, the recorded spray coverage was the lowest in the province at 50%.

The resumption of the campaign coincided with the onset of the rainy season, and competing socioeconomic activities, such as tilling of the land and planting, affected spray operations mostly in Masaiti, Mpongwe, and Lufwanyama districts (where people are predominantly farmers). Community members migrated to farming areas, leaving structures locked. Spray team deployment was adjusted, but in some cases, SOPs remained in these areas to allow for householders to return.

Eastern Province

All districts in Eastern Province completed their campaign on schedule, except Chadiza which extended the campaign by one day due to the reported low progress and coverage. In the first few days of the campaign in Chadiza, inadequate community mobilization and long distances between structures contributed to low progress. Mobilization activities in Chadiza were intensified by the use of a Public Address system which improved coverage. To obtain the desired results within the prescribed calendar, 85 SOPs from Katete district (who had completed their campaign) assisted Chadiza for two days.

Nchelenge District

The district excised 4,115 ineligible structures from the district-level target. To allow the district IRS team to find more structures and reach a minimum of 85% spray coverage, the campaign was extended by six days and ended on November 15. In addition, team leader assistants (TLAs) worked for an additional six days to tag structures that had not been tagged during the 36-day campaign due to software issues (see additional details under Section 6: Challenges).

Table 5: Campaign Length by District

Province	District	Campaign Details		
		Spray Days	Spray Start Date	Spray End Date
Eastern	Chadiza	31	02-Oct	11-Nov
	Katete	30	02-Oct	09-Nov
	Sinda	30	02-Oct	09-Nov
	Chipata	30	02-Oct	09-Nov
	Lundazi	30	02-Oct	09-Nov
	Mambwe	30	02-Oct	09-Nov
	Nyimba	22	02-Oct	08-Nov
	Petauke	30	02-Oct	09-Nov
	Vubwi	30	02-Oct	09-Nov
Copperbelt	Lufwanyama	42	02-Oct	30-Nov
	Masaiti	41	02-Oct	28-Nov
	Mpongwe	34	02-Oct	20-Nov
	Chililabombwe	34	02-Oct	19-Nov
	Chingola	32	02-Oct	20-Nov
	Kalulushi	31	02-Oct	16-Nov
	Kitwe	33	02-Oct	20-Nov
	Luanshya	33	02-Oct	27-Nov
	Mufulira	36	02-Oct	23-Nov
	Ndola	34	02-Oct	19-Nov
Luapula	Nchelenge	36	02-Oct	15-Nov

2.3.2 SUPERVISION

Monitoring and supervision of IRS operations were conducted throughout the campaign. At the core of the supervisory structure were the team leaders, who each supervised five SOPs. An IRS supervisor then managed two team leaders and their spray teams and reported to the IRS manager. The IRS manager was in charge of coordinating IRS supervision activities at the district level and was complemented by the PMI VectorLink District Coordinator. Inadequate supervision by GRZ supervisors in previous campaigns affected the quality of spray by SOPs. To enhance IRS supervision, in 2018 and 2019 spray seasons, VectorLink Zambia recruited and hired 50% seasonal supervisors to compliment GRZ supervisors. The project paired the two groups of supervisors to improve supervision, and ensure high spray quality and adherence to safety and environmental safeguards. Additionally, to enhance supervision, VectorLink made provisions for NMEP as well as provincial- and district-level staff to conduct monitoring and supervision of IRS activities. Additionally, to ensure adherence to PMI best management practices, both VectorLink Lusaka and field-based staff monitored and supervised morning mobilization activities, warehouse management, homeowner preparation, SOP performance as well as end-of-day clean-up. One prominent problem encountered was inadequate household preparation in Copperbelt, where the government has sprayed for the last several years. To improve household preparation, VectorLink conducted a one-day refresher training of the spray teams across Copperbelt during the weeklong hiatus. SOPs, team leaders, and supervisors alike participated in “live fire” simulations focused on household preparation, including explaining the importance of this step to household members. Additionally, to improve the quality of IRS through adequate household preparation, the team held another retraining in Ndola during the period.

VectorLink Zambia, in collaboration with DHOs, recruited spray personnel noted in Table 6.

Table 6: Number of Seasonal Workers Hired to Support IRS Disaggregated by Gender

Category	Number of Staff hired to Support IRS						Total (% Female)
	Spray Ops		Data Capture		Other		
	M	F	M	F	M	F	
Supervisors	128	43					171 (25%)
Mobilizers					5,440	1,398	6,838 (20%)
Spray operators	951	517					1,468 (35%)
Team leaders	206	98					304 (32%)
Team leader assistants			76	19			95 (20%)
Data entry clerks			25	37			62 (60%)
M&E assistants			32	9			41 (22%)
Storekeepers					46	27	73 (37%)
TOTAL M/F	1,258	658	133	65	5,486	1,425	9,052 (24%)
TOTAL	1,943		198				

2.3.3 OPERATIONS SITES

The project utilized a total of 51 IRS operations sites. Prior to the campaign, the team established 33 new operations sites in Eastern (18 sites) and Copperbelt (15 sites) Provinces as well as one site in Nchelenge district to avoid congestion, reduce spray teams' travel time in the field, and minimize camping by spray teams in remote sites. Furthermore, for sites that serviced more than 25 SOPs, the project constructed larger wash bays (8 x 4m) to accommodate two sets of rinse barrels to alleviate crowding and excessive wait times at the end of the day. Given the geographical vastness of the three rural Copperbelt districts (Lufwanyama, Masaiti, and Mpongwe) in which settlements are scattered and difficult to access in many areas, VectorLink established three operations sites in Masaiti and Mpongwe and two sites in Lufwanyama. In the seven urbanized districts, one operations site was set up per district. The community-based IRS technical approach utilized in Petauke necessitated the establishment of 13 new operations sites (one site to cover communities within a 10km radius) to make a total of 15 operations sites. In addition to the new sites established in Eastern Province (three in Chipata, one in Lundazi, and one Nyimba), the project rehabilitated the old sites in Lundazi (2), Nyimba (1), Chipata (3), Katete (2), Mambwe (2), Vubwi, Sinda (2), and Chadiza (1).

2.3.4 PAYMENT OF SPRAY PERSONNEL

In 2019, the PMI VectorLink project used a mobile payment system to pay seasonal workers including SOPs, team leaders, supervisors, storekeepers, M&E assistants, data entry clerks, and washers. Prior to the start of the campaign, seasonal personnel provided personal mobile money numbers to use for payment. Additionally, the project engaged the mobile network provider and made available extra SIM cards for spray personnel who did not have the required SIM cards. The project made payments twice—the first 10 days and the last 20 days including extensions. The project liaised with the mobile payment system provider to make agents available in all places including hard-to-reach areas, which allowed seasonal workers to access the money at their convenience. Spray personnel were paid after reviewing and confirming their daily participation using the attendance registers. The project paid mobilizers through cash in-hand because they stay in rural villages and have no phones which made it difficult to use mobile money payments.

2.3.5 PROCUREMENT

VectorLink Zambia procured IRS commodities both locally and internationally for the 2019 spray round based on the results of the logistics needs assessment which took into consideration leftover stock from the 2018 spray campaign. Whenever possible, the project procured items locally to ensure cost effectiveness and

timely delivery. This was done according to USAID and Abt protocols to ensure competition, transparency, and fairness. The procurement process involved use of an open, competitive bidding process for local tenders of commodities and services, which were evaluated by the VectorLink Zambia procurement committee and MOH provincial procurement officers in Lusaka. Based on historical consumption of insecticide in Zambian IRS campaigns, VectorLink estimated needing 174,026 units of insecticide to spray 617,000 structures.

2.4 INSECTICIDE STOCK MANAGEMENT

The project engaged two storekeepers at the main district operational site; the MOH district storekeeper and the VectorLink seasonal storekeeper. At all other operation sites, only the VectorLink seasonal storekeeper worked. The inclusion of the MOH district storekeeper was to enhance collaboration with the district and build IRS capacity for sustainability. To track insecticide usage, daily insecticide usage registers were used, along with stores ledgers, insecticide tracking logs, and stock control cards. The project introduced a serialized insecticide tracking book to reconcile insecticide usage between storekeepers and team leaders as well as a serialized insecticide tracking form to reconcile insecticide usage between team leaders and SOPs. This helped identify the culprit(s) when a sachet was missing. Table 7 shows the type, amount, and utilization ratio of insecticide procured in each province. The project used 151,299 sachets of insecticide (104,764 sachets of SumiShield and 46,535 sachets of Fludora Fusion) to spray 536,983 structures, for a utilization ratio of approximately 3.5 structures per sachet. Each SOP sprayed an average of 12.5 eligible structures per day.

The project reported a missing box of Fludora Fusion (containing 130 full sachets) during provincial insecticide distribution in Copperbelt. Additionally, eight full sachets of Fludora Fusion were lost at the Ipumbu IRS site in Mpongwe district during operations, amounting to a total of 138 full sachets of insecticides that went missing over the course of the campaign. In Eastern, the project reported one missing empty sachet in Mambwe and 14 missing empty sachets of SumiShield in Lundazi. The project reported the incidents to PMI and the Zambia Police for investigation (see Section 4).

At the end of the campaign, the project recorded 22,659 sachets of leftover insecticide (15,382 sachets of SumiShield and 7,277 sachets of Fludora Fusion) with an expiration date of January 2022 for Fludora Fusion and May 2021 for SumiShield. The leftover insecticide is safely stored in the provincial VectorLink warehouses in Chipata and Ndola until the 2020 spray campaign. The 2019 leftover IRS commodities will set a benchmark in planning for the 2020 spray season. Table 7 indicates insecticide consumption during the 2019 campaign.

Table 7: Insecticide Consumption in 2019, by Province

Province	Type of Insecticide	Qty procured by PMI	Qty used	Qty in stock	Avg # structures sprayed per sachet
Eastern	SumiShield	120,149	104,764	15,382 ¹	3.7
Copperbelt	Fludora Fusion	43,158	36,715	6,305 ²	3.3
Luapula	Fludora Fusion	10,792	9,820	972	3.2
TOTAL		174,099	151,299	22,659³	3.5

¹ Three sachets were used for entomology tests at TDRC (1), Kenya (1) and in Angola (1).

² In Copperbelt, VectorLink reported a missing box of insecticide (130 full sachets) during provincial distribution of IRS commodities and eight insecticide sachets at Ipumbu operations site in Mpongwe during operations

³ Total number of missing full insecticide sachets is 138 (Fludora Fusion). Remaining stock would have been 22,800, including the three used for entomological tests.

2.5 INFORMATION, EDUCATION, AND COMMUNICATION AND SOCIAL BEHAVIOR CHANGE COMMUNICATION ACTIVITIES AND RESULTS

In 2019, VectorLink Zambia worked closely with NMEP, DHOs, and key stakeholders to conduct information, education, and communication (IEC) and SBCC activities prior to the start of the campaign.

Drawing from lessons learned from the 2018 spray campaign, the project dropped the door-to-door mobilization method, in favor of headmen/section leaders-facilitated community dialogues two weeks prior to the start of the campaign. Subsequently, a day before spraying, the mobilizers (headmen/section leaders) notified their communities of the arrival of the spray teams the following day. In 2019, the project employed three major strategies for communicating IRS messages to the community which included: 1) district-facilitated advocacy/sensitization meetings with chiefs and influential community leaders; 2) community meetings by headmen/section leaders; and 3) communication through print (brochures and posters) and mass media. The outcomes of the SBCC intervention included the following:

2.5.1 ADVOCACY MEETINGS WITH CHIEFS AND INFLUENTIAL COMMUNITY LEADERS

The project used a total of 6,838 headmen and section leaders in rural and peri-urban areas, respectively, to conduct community sensitization and mobilization. In September 2019, the project collaborated with NMEP, PHOs, and DHOs and held provincial level advocacy meetings with chiefs and influential community leaders, including those from faith-based organizations. To get the support and buy-in of the chiefs and community leaders for the IRS campaign, the project held three advocacy meetings in Nchelenge (Luapula), Ndola (Copperbelt), and Chipata (Eastern). Additionally, the project used advocacy meetings to sensitize key stakeholders in attendance about IRS and share general campaign start and end dates. Traditional chiefs and Indunas, influential community leaders, district health directors, the provincial health director, the district commissioner for the host district, and the permanent secretary for the province and NMEP representatives were among the attendees. A total of 138 participants attended across three provinces (45 from faith-based organizations, 55 chiefs and 38 other key stakeholders). Chiefs then held advocacy meetings with their subjects (headmen/section leaders) to cascade the messages from the provincial advocacy meetings. The headmen/section leaders then disseminated the key points to the community members at community dialogue meetings.

2.5.2 COMMUNITY MEETINGS AND DIALOGUE

Chiefs within each district held orientation meetings with headmen and section leaders two weeks prior to the start of the campaign. In total, chiefs held 80 meetings across three provinces with 7,574 participants in attendance. The district health promotions officers, IRS managers, and VectorLink district coordinators attended the meetings and used this platform to orient and distribute IEC materials and spray calendars to headmen and section leaders and clearly explain the roles of headmen and section leaders as mobilizers in the 2019 campaign. Subsequently, one week to the start of the campaign, headmen and section leaders held community meetings and dialogues on IRS, clearly indicating when each community would be visited by spray teams. A total of 11,234 community meetings and dialogues on IRS were held prior to the start of the campaign. Additionally, headmen and section leaders notified their communities one day before spraying and guided spray teams during IRS operations for ease of navigation. This strategy worked very well in Eastern Province. In Copperbelt, however, not all headmen were effective, which contributed to lower-than-expected spray progress and coverage in the first four weeks of IRS operations. As such, during the one weeklong hiatus, VectorLink, in close collaboration with NMEP and PHO, embedded two mobilizers from NHCs per spray team to complement the efforts of headmen and section leaders.

2.5.3 PRINT AND MASS MEDIA COMMUNICATION

In 2019, VectorLink used two main radio programming initiatives, namely: radio spots (jingles) and discussions (interactive shows) about IRS and its benefits. Radio spots commenced airing two weeks before the start of the spray campaign and continued two times per day for three days each week throughout the campaign. The project aired a total of 420 spots across the three provinces through local radio stations. To address community's concern and improve IRS acceptance, the project supported a total of 20 radio discussion across two provinces and Nchelenge district. To monitor airing of jingles and radio discussions, the project engaged an independent media house which submitted a report at the end of the campaign

confirming that this activity took place. Both radio spots and radio discussions were aired using fewer, strategically-selected stations that reached the entire province. This strategy helped in reducing the cost of purchasing radio spots by 100 fewer spots.

Additionally, VectorLink Zambia worked closely with the MOH and the NMEP through the IEC/SBC Technical Working Group (TWG) to review and update IRS IEC materials. Subsequently, the project produced and distributed a total of 13,100 copies of IEC materials: 11,000 “IRS Frequently Asked Questions” sheets, 1,000 copies of talking points for religious and community leaders, 1,000 IRS posters and 100 IRS radio discussion guides.

2.5.4 NCHELENGE SBCC ASSESSMENT

To improve community acceptance of IRS in Nchelenge, which had been a problematic district for several years with regards to IRS acceptance, in July 2019, VectorLink, through PSI, conducted a rapid assessment to identify influential determinants of IRS acceptance there. The overall objective of the study was to produce a behavior change framework which would provide an evidence base for the NMEP with PMI and other stakeholders to prioritize communication messages, channels, geographic targeting, and approaches to raise awareness about the importance of IRS and address misconceptions or myths about IRS. PSI worked with the NMEP, district health team, PMI, VectorLink, and partner staff to conduct a Barrier Analysis. Below are the key findings, regarding the perception of IRS in Nchelenge since inception in 2010:

- The community did not associate malaria to mosquito bites and believed that IRS was not effective.
- The community believed that IRS causes adverse health effects, especially with the pungent smell of insecticides used.
- The community complained that household preparation was difficult to meet the required standard.
- Communities indicated that they usually did not know about the spray operations and only saw SOPs on the actual spray day in their communities.
- Residents suspected that SOPs over-diluted the insecticide leading to an increase of mosquito population after spray.

Based on the findings and 2018 experiences, VectorLink, jointly with NMEP and the district health team, identified priority communication and programmatic activities to address the behavioral determinants of IRS acceptance identified as part of the framework. Additionally, the project implemented “tried and true” activities for mobilization, community outreach, and mass media promotion and education to ensure improved community acceptance. The implementation of these activities led to marked improvement in IRS acceptance.

2.5.5 SUCCESS STORIES

VectorLink Zambia published two success stories on the VectorLink project-wide website in 2019. One featured the VectorLink-led national training of GRZ environmental health technicians in entomological monitoring and morphological identification of *Anopheles* mosquitoes, and the other highlighted and the project’s successful hosting of John Hopkins University Masters of Engineering students for a three-day hands-on entomological training. In addition, VectorLink published a story on the PMI field visit at the beginning of the 2019 spray campaign which was posted on the VectorLink project-wide website.

2.6 POST-SPRAY ACTIVITIES

2.6.1 INVENTORY ASSESSMENT AND DEMOBILIZATION

At the end of the campaign, the project conducted physical counts of IRS materials and equipment at various operational sites. One week after the campaign, the team transferred all leftover commodities and equipment from the operations sites to the provincial warehouses. The project tested equipment for proper functioning

and then isolated broken equipment for repair prior to the 2020 campaign. Unserviceable equipment will be discarded in an environmentally sound manner. The project received PMI's concurrence to loan 950 sprayers to NMEP to use during GRZ-supported IRS which started after PMI IRS campaign was concluded, and was facing bottlenecks due to delayed arrival of the GRZ/Global Fund pump procurements.

2.6.2 POST-SPRAY REVIEW MEETINGS

To effectively evaluate the 2019 IRS experiences, challenges, and lessons learned, as well as recommendations for the future, VectorLink provided financial and technical support to the NMEP to hold one-day post spray review meetings in each province from December 13 to 18. Eastern Province held its meeting on December 13 in Chipata; Nchelenge district on December 16; and Copperbelt province on December 18 in Ndola. To ensure that recommendations were made on key areas of challenges, participants broke into groups to discuss: 1) recruitment and training; 2) community sensitization and mobilization; 3) environmental compliance and IRS supervision and; 4) data management and sustainability. Key recommendations from these meetings, whose details are captured in Section 6, were factored into the development of this report and will also serve to inform the 2020 work plan.

2.7 CAPACITY-BUILDING EFFORTS

The key element of the VectorLink Project is to build the capacity of the national program to enable GRZ to carry out IRS with minimal external support. In 2019, VectorLink focused its capacity-building efforts on the following areas: (1) completion of the national capacity assessment which started in 2014; (2) technical assistance (specifically in environmental compliance) to GRZ-supported IRS districts using DDT for IRS; (3) national entomological capacity; (4) support and participation in IRS technical working group; (5) DHIS2 capacity-building workshop for country stakeholders; and (6) informed, evidence-driven vector control decision-making.

In July 2019, VectorLink completed a capacity-building assessment and developed a tailored national capacity-building plan to address the identified gaps. To strengthen national entomological capacity, VectorLink provided mentorship to NMEP staff at the central level to supervise entomological monitoring, analyze the data, and use the results for strategic decision-making. Additionally, the VectorLink technical manager supported NMEP in analyzing and interpreting entomological data which was essential for decision-making regarding insecticide selection for IRS implementation. To strengthen IRS technical working group, VectorLink contributed technical presentations at the TWG meetings; participated in developing and financially supported the printing of annual IRS activity plan; actively participated in the mid-term review of the 2017/21 malaria elimination strategic plan; and participated in developing the IRS guideline and best practices. In addition to the technical contributions, VectorLink Zambia provided financial support to hold the quarterly meetings of the IRS TWG. Similarly, prior to the start of the campaign, VectorLink Zambia M&E team trained GRZ stakeholders on the VectorLink Collect database to using spray data to monitor daily spray performance and for decision-making. To build the national capacity for informed, evidence-driven vector control decision-making, VectorLink, through core partner PATH, held a stakeholders' workshop in integrated data analytics and visualization with a focus on IRS planning.

Lastly, to achieve its objective of providing technical assistance to GRZ during transition to DDT use, VectorLink technically supported districts in Northern (9), Luapula (8), and Muchinga (1) provinces by implementing the following:

- Prior to the start of the campaign, the project supported the VectorLink in-country environmental compliance officer (ECO) and the Vector Control Specialist from NMEP to undertake a study tour in Zimbabwe to learn environmentally sound management of IRS operations with DDT including effluent and solid waste management.
- VectorLink's Director of Environmental Compliance and Safety traveled to Zambia and, supported by the ECO, participated in the training of trainers (TOTs) of GRZ personnel on DDT waste management

where he demonstrated how to make, install, and use mobile filters for safe management of effluent from end-of-day clean up.

- The project supported the NMEP in the procurement of the local materials, formation, and transport of 61 mobile soak pits for use to manage effluent in DDT operations in Muchinga, Luapula, and Northern Provinces. Materials included granular activated charcoal, 60-liter barrels, sponges, screens, 20-liter buckets, and stands for supporting the filters.
- VectorLink in-country ECO provided technical support during implementation of IRS with DDT by the GRZ through monitoring and supervision in Luapula and Northern Provinces. The project also supported two NMEP staff to supervise in DDT districts.

2.8 GENDER MAINSTREAMING

To ensure that all program activities aligned with USAID’s policy on gender equality, VectorLink Zambia included modules on gender in all trainings (TOTs, team leader, SOP, storekeeper, and M&E). As such, participants understood the importance of integrating more females into spray teams to ensure equal participation in all aspects of IRS. The project’s goal in 2019 was to attain 40% female inclusion to support IRS operations. The project achieved 33%, an increase from the 2018 spray season where female inclusion reached 31%. The inability of the project to attain the 40% target could be attributed to the fact that there was a low turnout of females during recruitment and also the majority of females who attended interviews failed to pass the standardized test. To ensure that female personnel were comfortable and felt safe to participate in the program, the project made the following provisions:

- Used IEC posters with pictures of female SOPs to motivate women to join the IRS program.
- Posted sexual harassment posters at all the operations sites and DHOs to encourage personnel to report all forms of harassment they observe.
- Established wash facilities with adequate privacy for both genders.
- Upheld the Zambian labor law that allows for female personnel to take one day off each month.
- Provided sanitary pads and sanitary bins for hygienic disposal of pads.
- Provided suitably-sized personal protective equipment (PPE) to ensure that female SOPs felt comfortable as they participated in the operations.

VectorLink Zambia has experienced an increase in female inclusion in the program since 2018. The team will continue to dialogue with the NMEP and other stakeholders to work towards equitable engagement of women and men in future IRS campaigns.

2.9 PILOTING OF COMMUNITY-BASED IRS

VectorLink Zambia’s district-based IRS operations design has traditionally used motor vehicles for the duration of the campaign to transport spray teams from the operations site to spray areas. In 2018, the project piloted a quasi-community-based approach that involved switching from using trucks to the use of bicycles to deploy spray teams when the campaign progressed within 10km of the operations base to reduce transportation cost. VectorLink implemented this approach in three districts (Mpika, Luwingu, and Mwansabombwe) in 2018 and replicated it in Lundazi in 2019.

In Petauke, the project established additional operations sites to reduce distances from sites to the target communities, allowing SOPs to use bicycles for the duration of the campaign. The project set up five main sites that were each supported by two sub-sites, and spray teams from each site were dispatched to cover areas within 10km radius.

The team selected Petauke and Lundazi districts because the terrain is mostly flat and thus suitable for bicycle use. The team notified all prospective spray personnel (SOPs and team leaders) in the districts during

recruitment that ability to provide and ride a bicycle was a prerequisite for their recruitment. VectorLink paid SOPs and team leaders a daily bicycle maintenance allowance of 20 kwacha per person for the period they used bicycles.

2.9.1 KEY FINDINGS

- Spray teams used 218 and 181 bicycles in Lundazi and Petauke districts for 4 and 30 operational days, respectively.
- Spray teams managed to organize bicycles ahead of time.
- Use of bicycles simplified deployment of SOPs.
- Use of bicycles expedited movement in widely-dispersed communities.
- Use of bicycles simplified accessibility in hard-to-reach areas by vehicles.
- Higher than expected progress and coverage from the onset of the campaign resulted.
- Establishing 13 new IRS operations sites resulted in higher costs in the community-based approach as opposed to a centralized or district-based approach which utilizes a minimum of one site. Recruitment criteria that required personnel to provide and ride a bicycle simplified implementation of the pilot.
- The bicycle allowance of K20 motivated and encouraged spray personnel to work harder.
- Easy management of insecticides and other IRS commodities at the local storage sites resulted from the small numbers.

Table 8 shows the summary of the cost analysis on use of vehicles versus use of bicycles to ferry spray personnel during the two community-based approaches used in Petauke and Lundazi.

Table 8: Cost Analysis of Community-Based and Quasi-Community Based IRS

District	Use of Vehicle								Community-Based IRS/ Quasi-Community-Based IRS				Cost Savings
	Days	No. of Vehicles	Vehicle Hire/day (ZMW)	Total Cost of Vehicle Hire/Day (ZMW)	Fuel/Vehicle/Day (L)	Fuel /L (ZMW)	Total Cost of Fuel/Day (ZMW)	Total Cost for Period (ZMW)	Days	No. of Bicycles	Bicycle Allow./Day (ZMW)	Total Cost (ZMW)	Total Cost Saved (ZMW)
Petauke	30	8	700	5,600	20	14.25	2,280	236,400	30	181	20	108,600	127,800
Lundazi	4	9	700	6,300	20	14.25	2,565	35,460	4	218	20	17,440	18,020
Total	34	17	700	11,900	20	14.25	4,845	271,860	19	100	20	126,040	145,820
Total Cost Saved (Vehicles vs. Bicycles)											145,820 ZMW (about 10,392 USD)		

2.9.2 CHALLENGES

- In a few instances, bicycle breakdowns led to reduced daily spray coverage by SOPs.
- In some instances, spray teams cycled longer than expected (15km) due to underestimation of distances from operations sites to spray areas.
- Minor incidences involving spray pumps falling off the bicycle in three instances.

2.9.3 CONCLUSION

The adoption of community-based IRS in Petauke reduced transportation costs for spray teams, saving the project 127,800 ZMW (about 9,108 USD), whereas quasi-community based IRS in Lundazi resulted in the cost savings of 18,020 ZMW (about 1,284 USD). In Petauke, the project established 13 new IRS operations sites at the cost of 1,280,273 ZMW (about 91,243 USD). While these additional start-up costs are substantial and must be carefully considered prior to scale-up, the cost of continuing to implement community-based IRS in pilot districts will be significantly less in subsequent years given the establishment of new sites has already occurred.

The project should consider scaling up quasi-community-based IRS approach in 2020 to districts where the terrain is conducive to bicycle transportation. This will drastically reduce transport costs when more districts are involved and may lead to sustainability.

3. ENTOMOLOGY

VectorLink Zambia supports the NMEP in generating data on key entomological indicators through routine entomological surveillance, insecticide resistance monitoring, and the assessment of residual efficacy of insecticide on the walls after IRS. These data guide the NMEP and other stakeholders on vector control decision-making, such as insecticide selection for IRS and insecticide resistance management. VectorLink currently conducts entomological surveillance and insecticide resistance monitoring activities in five PMI-supported districts and two districts supported by the Global Fund and GRZ. The assessment of spray quality was conducted in seven PMI supported districts while the longitudinal assessment of residual efficacy is taking place in five of the districts. Three of the PMI-supported districts in 2018 (Mwense, Kasama, and Isoka) were transitioned to GRZ for entomological surveillance in 2019 and were replaced by three new districts (Nchelenge, Lufwanyama, and Chililabombwe). These changes resulted from the shift in geographic focus of PMI support for IRS in Zambia from three previously-supported provinces (Luapula, Northern, and Muchinga) to the Copperbelt Province.

The entomology section in this report focuses on the susceptibility of local vectors to the IRS insecticides and the insecticide residual efficacy activities conducted during the 2019 spray campaign. The progress and annual reports will include a comprehensive report on this and other entomologic indicators.

3.1 INSECTICIDE SUSCEPTIBILITY TESTS

The Insecticide Resistance Monitoring and Management/Technical Advisory Committee of the National Malaria Elimination Program in Zambia recommended two insecticides for the 2019 IRS campaign: DDT and clothianidin. Susceptibility of the local malaria vectors to DDT (4%) and the neonicotinoid clothianidin (13.2mg/paper) were tested at some sites in the provinces where PMI VectorLink supports entomological monitoring. The susceptibility tests were conducted using standard WHO tube tests; mortality was determined 24 hours after exposure for DDT and up to seven days after exposure for clothianidin. The test results are presented for the two main local vectors *An. funestus* s.l. and *An. gambiae* s.l. in Figures 2 and 3 respectively. *An. funestus* s.l. and *An. gambiae* s.l. were both fully susceptible to clothianidin at all the sites tested. PMI VectorLink conducted IRS in the 2019 campaign using only clothianidin products (SumiShield and Fludora Fusion). There was either probable (mortality 90-97%) or confirmed (mortality <90%) resistance to DDT in at least one site in Luapula, Eastern and Copperbelt provinces. These test results including the results we obtained for other insecticides - pirimiphos methyl, bendiocarb, deltamethrin, and chlorfenapyr were submitted to the 2020 Insecticide Resistance Monitoring and Management/Technical Advisory Committee's technical working group in January 2020 and were used alongside data from other partners in the selection of insecticides for the 2020 campaign. Susceptibility tests are currently ongoing; more sites are being tested for clothianidin and tests will be conducted for chlorfenapyr (a future IRS product) and for pyrethroid insecticides. These will be used in the decision making process for 2021.

Figure 2: Susceptibility Status of *An. funestus* s.l. to Clothianidin and DDT at PMI VectorLink Entomological Monitoring Sites

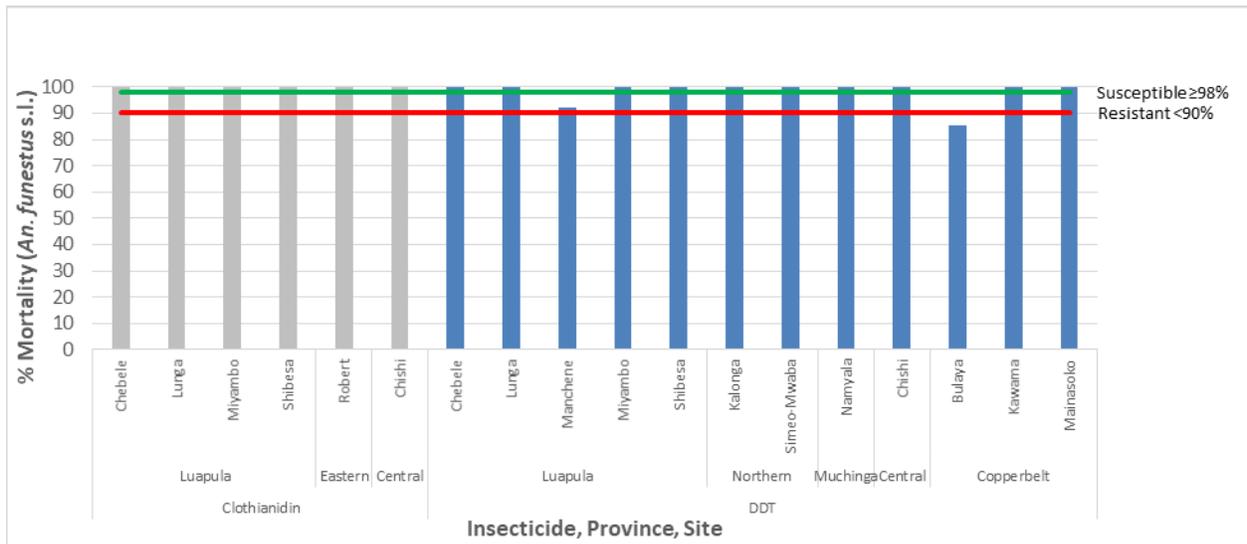
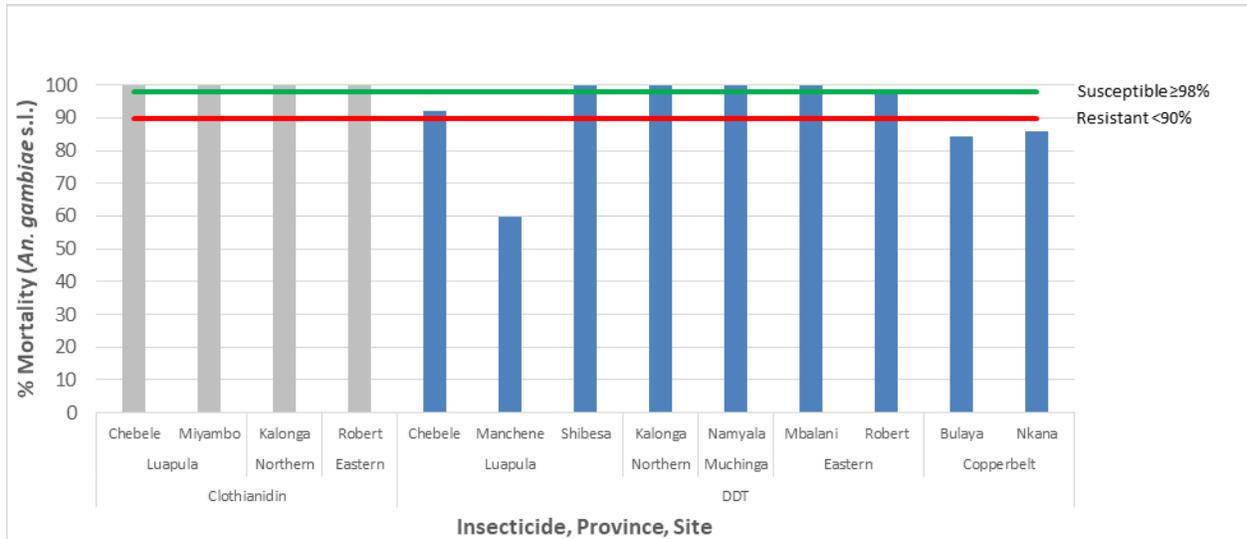


Figure 3: Susceptibility Status of *An. gambiae* s.l. to Clothianidin and DDT at PMI VectorLink Entomological Monitoring Sites



3.2 IRS SPRAY QUALITY ASSESSMENT

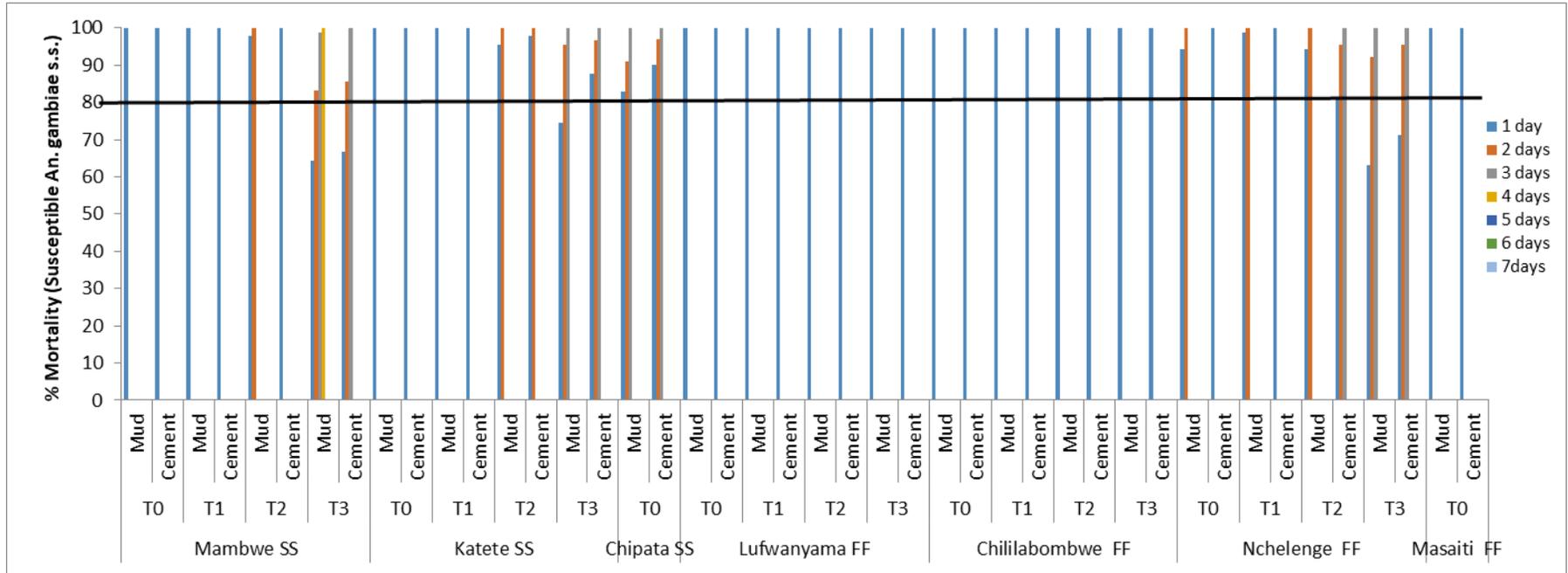
VectorLink Zambia conducted cone bioassays to assess the quality of spray during the 2019 IRS campaign in seven PMI-supported districts: Katete, Mambwe, Chipata, Lufwanyama, Chililabombwe, Masaiti, and Nchelenge in October 2019. Cone bioassays were conducted using the World Health Organization (WHO) test procedures in three randomly-selected mud houses and three randomly-selected cement houses in each site. In addition, cone bioassays were conducted in one unsprayed mud house and one unsprayed cement house in each site as controls. A total of 42 sprayed houses (21 mud and 21 cement) and 14 unsprayed houses (7 mud and 7 cement) were assayed during the campaign 24 hours after each selected house was sprayed (T0). In each house, a total of 30 mosquitoes were exposed in groups of 10 in cones placed at 0.5m, 1.0m, and 1.5m above the floor. All mosquitoes exposed to walls sprayed with SumiShield were dead after the 24-hours except in Chipata where 100% mortality was achieved at 72 hours post exposure. Similarly, all mosquitoes exposed to walls sprayed with Fludora Fusion were dead after 24 hours, except for Nchelenge where 100%

occurred at 48 hours. Control mortality was below the 5% threshold, and therefore corrected mortality was not necessary. There was no difference in mortality observed between the different cones in each house which means the insecticide was sprayed uniformly on the walls from top to bottom. The data signify that the 2019 IRS campaign achieved a high quality of spray. Figure 2 provides a summary of the bioassay results.

3.3 RESIDUAL EFFICACY

VectorLink Zambia conducts monthly cone bioassays to monitor the duration of residual efficacy of the insecticides in five districts: Katete, Mambwe, Lufwanyama, Chililabombwe, and Nchelenge. T1 cone bioassays were conducted in November, T2 assays in December, and T3 assays in January (one, two, and three months after IRS, respectively). In each month, 30 sprayed houses (15 mud and 15 cement) and 10 control (unsprayed) houses (5 mud and 5 cement) were assayed. At T1 and T2, the 80% mortality threshold was achieved after 24 hours for all wall surface types, while at T3 80% mortality was achieved after 48 hours in Mambwe, Katete (mud surface only), and Nchelenge (Figure 2). This indicates that both insecticides last for at least three months. Residual efficacy monitoring will continue in each district until mortality falls below the 80% threshold for two consecutive months which will indicate a loss of residual efficacy. The results will be presented in the progress report and the annual report.

Figure 4: Mortality of *An. gambiae* s.s. Kisumu Susceptible Strain after Exposure to SumiShield and Fludora Fusion in Select Districts



SS=SumiShield, FF=Fludora Fusion

4. ENVIRONMENTAL COMPLIANCE

4.1 IRS CAMPAIGN ASSESSMENTS

4.1.1 PRE-SEASON ENVIRONMENTAL COMPLIANCE ASSESSMENTS

In June 2019, the VectorLink Zambia Environmental Compliance Officer (ECO), along with provincial and district health officers, conduct Pre-Season Environmental Compliance Assessment (PSECA) all IRS operations sites, to check the preparedness of IRS facilities such as warehouses, soak pits, shower rooms, pit latrines, and wash areas. An Open Data Kit application through a smartphone was used to complete both the initial and final PSECAs. Data collected were uploaded to the Abt Associates environmental compliance database and generated a “green light” if the site was ready, or a worklist with remedial actions to be taken if there was a deficiency.

VectorLink Zambia constructed and used 20 mobile soak pits (MSPs) in camp sites where the distance to a fixed soak pit at the operations site was too great for spray teams to return each day.

The ECO and district coordinators revisited all IRS operations sites two weeks prior to the launch of the campaign to verify the completion of all rehabilitation activities and confirm the readiness of each operations site for the 2019 IRS campaign. All storage facilities in PMI-supported districts met the minimum environmental compliance requirements and were certified to safely store insecticides. Additionally, all soak pits were suitable for disposal of insecticide-contaminated liquid waste.

4.1.2 PRE-CONTRACT MOTOR VEHICLE INSPECTIONS

In September 2019, prior to finalizing vehicle contracts, VectorLink Zambia and local traffic police inspected all vehicles designated to transport spray teams to ensure they complied with PMI best management practices (BMP) regarding safety and environmental standards.

VectorLink Zambia oriented 72 drivers on safety and environmental compliance for insecticide transportation and handling two weeks prior to the commencement of the campaign. All 72 vehicles were equipped with spill management and first aid kits, Material Safety Data Sheets, and accident/emergency response procedures.

4.1.3 MEDICAL CLEARANCES

All personnel hired for the 2019 spray season underwent medical examinations to assess their physical fitness for the program’s demands. Additionally, all female recruits were administered pregnancy tests before the IRS campaign to ensure no expectant mothers were at risk of exposure to insecticide. After 30 days, tests were repeated. No female tested positive based on the two tests conducted.

4.1.4 MID-SPRAY ENVIRONMENTAL COMPLIANCE INSPECTIONS

VectorLink Zambia staff monitored environmental compliance throughout the campaign in close collaboration with MOH employees using environmental compliance tools embedded on smartphones. At the end of the campaign, the team summarized the inspection results, which formed the basis of the Environmental Mitigation and Monitoring Report (Annex B).

4.1.5 MORNING MOBILIZATION

Eating and drinking while applying insecticides were strictly regulated due to the risk of exposure from insecticides. As part of morning mobilization, SOPs reported to a restaurant for a large meal and were encouraged to hydrate fully. To ensure SOP and householder safety, the ECO, team leaders, and IRS supervisors inspected all SOPs to identify any symptoms of illness such as intoxication, difficulty in breathing, fatigue, weakness, or dizziness. SOPs were reminded not to touch/wipe their face while wearing gloves to avoid exposure to insecticide. Additionally, emphasis was made to on the severity and consequences of data falsification and insecticide theft, which was further reinforced by posters on stores at the operations bases. This morning routine was a daily reminder to SOPs and spray teams on correct field operations.

4.1.6 HOMEOWNER PREPARATIONS AND SOP PERFORMANCE

Household inspections were performed while SOPs were in the field conducting IRS. Supervisors interviewed homeowners to assess whether they had received adequate information on their responsibilities. While few environmental compliance irregularities were reported, concerns included:

- Some residents refused IRS, claiming that they had not been informed prior to spray date.
- Some residents did not remove the recommended movable items in preparation for spraying. This was particularly pronounced in the Copperbelt where most residents refused to remove household items from their houses, especially from bedrooms.

These issues occurred primarily in the initial stages of the campaign. Refer to Section 2.3.2 and Annex B for details and quantification.

4.1.7 STOREKEEPER PERFORMANCE INSPECTIONS

PMI VectorLink staff monitoring and supervising IRS operations conducted store audits at every site they visited. Most discrepancies in insecticide stock were resolved after physical counts of the stock were conducted until the number of empty and full sachets matched the opening stock. As the program progressed, most storekeepers improved their performance, and few compliance issues were reported.

4.1.8 END-OF-DAY CLEAN-UP INSPECTIONS

End-of-day clean-up inspections were conducted at IRS operations sites and camp sites where MSPs were used. Fewer compliance issues were observed during end-of-day clean-up this year compared to previous spray seasons, which is attributed to the daily review of correct clean-up protocols with SOPs. Refer to Table 10 and Annex B for more details.

4.2 INCIDENT REPORTS

The project reported 18 incidents to PMI during the 2019 spray campaign, in accordance with incident reporting requirements. Table 9 provides a brief summary of each.

Table 9: Environmental Incidents Reported during the 2019 IRS Campaign

	BRIEF DESCRIPTION	LOCATION
1	Improper disposal of empty insecticide sachets.	Chingola district
2	Improper disposal of empty insecticide sachets.	Chingola district
3	Missing box of Fludora Fusion (130 x 100g sachets). An official police report is pending.	Copperbelt province
4	Seven empty sachets of insecticide missing from operations site store room.	Lundazi district
5	Exposure to insecticide: Six spray personnel (five SOPs and one team leader) from developed a rash on the upper parts of their bodies.	Mambwe district

	BRIEF DESCRIPTION	LOCATION
6	Exposure to insecticide: A female SOP complained of itchiness on her face.	Ndola district
7	One empty sachet of insecticide missing—insecticide usage of the SOP coincided with the number of structures sprayed.	Nchelenge district
8	An SOP was traumatized after finding a snake while preparing a household for IRS.	Mpongwe district
9	Six empty sachets of insecticide missing from Mwimba operations site storeroom. Documentation showed that the team leaders had handed in the right quantities of full and empty sachets.	Lundazi district
10	Falsified data: Two SOPs inflated the number of structures sprayed when compared to actual data. Both SOPs were dismissed.	Mufulira district
11	Motorcycle accident: A VectorLink M&E assistant was on an off duty, non VectorLink-related activity when he was involved in a road traffic accident where a pedestrian was hit by the motorcycle and later died.	Petauke district
12	One empty sachet of insecticide missing from Lundazi Boma site storeroom.	Lundazi district
13	Insecticide pilferage: A SOP was found with insecticide in his bag that had been emptied into a plastic bag. The SOP contract was terminated.	Chadiza district
14	One empty sachet of insecticide missing from DHO storeroom.	Mambwe district
15	Falsified data/insecticide pilferage: Two SOPs inaccurately reported the number of structures sprayed and attempted to steal insecticide which they hid in their personal bags.	Nchelenge district
16	Insecticide pilferage: nine full sachets of insecticide were missing from the storeroom at Ipumbu operations site. The matter was reported to the police for further investigation.	Mpongwe district
17	Falsified data: Two SOPs at Chilese operations site reported spraying extra structures which did not exist. The two SOPs' contracts were terminated.	Masaiti district
18	Falsified data: A SOP inflated the number of structures sprayed. The spray operator's contract was terminated.	Masaiti district

4.3 DEMOBILIZATION AND WASTE MANAGEMENT

4.3.1 POST-SEASON ENVIRONMENTAL ASSESSMENTS

The VectorLink Zambia logistics coordinator, ECO, and district coordinators, in collaboration with MOH district representatives, conducted post-spray season environmental assessments of IRS operations sites between December 1 and 13, 2019.

4.3.2 IRS WASTE DISPOSAL

Table 10 summarizes how IRS waste is disposed of at the end of the campaign.

Table 10: Summary of Type, Quantity, and Disposal Method of 2019 IRS Solid Waste

Type	Quantity	Disposal Method
Empty SumiShield sachets	104,749 sachets	Will be incinerated at UTH in Lusaka by January 31, 2020
Empty Fludora Fusion sachets	46,535 sachets	
Plastic sheets	399 kg	Torn plastic sheets that could not be reused were disposed at the national dumpsite in Lusaka after thorough cleaning
Face shields	985 kg	Face shields that were broken and could no longer be reused were disposed of at the national dumpsite in Lusaka after thorough cleaning

Type	Quantity	Disposal Method
Boots and helmets	58 kg	Given to deserving SOPs after thoroughly cleaning with soap and water
PVC gloves	313.8 kg	Cleaned with soap and water, shredded, then disposed of in landfill
Used nose masks	615.8 kg	Weighed at provincial IRS warehouse, then incinerated at UTH
Mutton cloths/ handkerchiefs	252.6 kg	SOPs were allowed to keep mutton cloth used as neck protection after washing with soap and water. Handkerchiefs used during mixing of insecticide will be weighed and incinerated at UTH.
Overalls	43 units	Worn-out overalls will be given to deserving SOPs after being thoroughly cleaned with soap and water.
Backpacks	72	Bags will be given to deserving SOPs after being thoroughly cleaned with soap and water.
Empty boxes	461 kg	VectorLink will incinerate contaminated boxes and will donate uncontaminated boxes to Zambezi Paper Mills company as raw material

5. MONITORING AND EVALUATION

5.1 DATA COLLECTION, ENTRY, AND QUALITY ASSURANCE

VectorLink Zambia considered and adopted the successful aspects of the M&E system from the 2018 IRS campaign to ensure high-quality data collection, management, and reporting. During the TOT for IRS managers and supervisors, the M&E team reviewed and trained IRS managers and supervisors on the Daily Spray Operator form, Team Leader form, and Directly Observed Spray form. IRS managers and supervisors explained the forms during the cascade training for SOPs and team leaders. The SOP form served as the primary tool for data collection. In addition to the SOP Forms the Team Leader Forms and Data Collection Verification Forms were used to supervise and improve data collection.

Prior to the 2019 IRS spray campaign, the project established seven data centers across the two target provinces: three in Eastern (in Chipata, Petauke, and Lundazi) and four in Copperbelt (Ndola, Kitwe, Kalulushi, and Chingola). Data centers were established in strategic locations where connectivity was stronger to support the data entry/cleaning across 16 districts. Data from the other four districts was entered into the Reveal tool (formerly mSpray) with the support of PMI VectorLink partner Akros (see Section 5.1.1). To support data collection and entry and the supervision of both activities, VectorLink Zambia hired M&E assistants in all districts, who were also responsible for delivering the forms to the data center supervisor. Data entry clerks (DECs) are required to enter data within 48 hours after structures were sprayed. First, the spray “Totals” (summary of each Daily SOP Form) were entered within 24 hours to produce “real-time” reporting of spray progress. Later, the spray “Details” (household-level data) were entered within 48 hours for a more accurate picture of spray progress and coverage. By using the cleaning tool, DECs investigated and reconciled discrepancies between spray “Totals” and “Details” data for a final data set with the campaign results. DECs entered data into VectorLink Collect, the project’s DHIS2-based data platform. The M&E Team, Abt’s DSET team, and BAO Systems worked together to update VectorLink Collect for the 2019 IRS campaign. DECs primarily used a desktop application to enter spray data since it functions offline, which was important given the unstable internet connectivity experienced at the designated data centers. All electronic data are securely stored and backed up on VectorLink servers which are hosted by BAO Systems team. VectorLink Zambia technical staff also used the database to generate near “real-time” reports for quick feedback and to reconcile and prevent additional errors in data collection and entry.

Based on the team’s experience in 2018, the M&E team reviewed the data from the VectorLink Zambia database on a weekly basis and provided feedback to provinces and districts on performance and coverage, highlighting areas that had not achieved 90% coverage. The report also indicated the number of structures to be revisited through a mop-up campaign to attain 85% coverage. The M&E team sent the weekly report to PMI VectorLink technical staff, NMEP staff, district coordinators, chief environmental health officers, IRS managers, and district health directors.

DECs filed SOP forms at the district data centers according to spray date and team number and backed up spray data daily to a computer hard disk and an external hard drive for data security and storage.

5.1.1 DATA COLLECTION USING REVEAL

The Reveal platform, which is managed by Akros, was built using the lessons learned from the mSpray tool and was deployed for the 2019 campaign. mSpray has been used in Zambia since 2014 by both PMI AIRS Zambia and the follow-on PMI VectorLink Zambia projects. Using satellite mapping technology, Reveal enumerates structures in a given geographical area. Furthermore, Reveal allows spray personnel to collect spray data and GPS coordinates using a tablet. Data are uploaded to ONA at the end of each day for spray campaign progress. The following are key features of the Reveal tool for data collection and management:

- Data are captured directly on mobile forms using a smartphone or tablet.
- Pre-programmed data entry controls on mobile devices reduce illogical data errors.
- Near real-time data are available via and the Reveal dashboard to immediately address campaign challenges and improve spray progress.

VectorLink Zambia used the Reveal tool in four PMI-supported districts—three pre-elimination districts in Eastern Province (Chadiza, Katete, and Sinda) as well as in Nchelenge district of Luapula Province—for mobile spray data collection and reporting. As in non-Reveal districts, SOPs collected spray data on paper SOP forms. In the three pre-elimination districts, one TLA was assigned four SOPs, and while in Nchelenge, one TLA was assigned three SOPs.

5.1.2 DATA COLLECTION VERIFICATION

M&E Assistants conducted random field checks by visiting target areas that had been sprayed within the previous three days to interview households using the Data Collection Verification (DCV) Form. Moreover, PMI VectorLink technical staff and MOH supervisors conducted field spot checks to validate data authenticity. This enabled VectorLink Zambia to validate spray data and, in a few instances, identify SOPs who falsified data. There were instances of data falsification in Mufulira (one instance involving two SOPs), Chadiza (one instance involving one SOP), Nchelenge (one instance involving two SOPs), and Masaiti (two instances involving three SOPs). A thorough review and investigation revealed that all eight personnel recorded non-existent structures as sprayed and were therefore guilty of data falsification and dismissed.

5.2 MHEALTH IMPLEMENTATION

VectorLink Zambia collaborated with Dimagi to ensure quality reporting and supervision in all target districts. In 2019, the Dimagi platform included daily SMS reminder messages, electronic DCV forms, PMT, and supervisory checklists.

5.3 IRS CAMPAIGN RESULTS

Out of the 598,732 structures found in the targeted districts, VectorLink sprayed 536,983, for a spray coverage of 90%. The campaign protected 2,273,188 people including 50,100 pregnant women and 318,396 children under 5. Table 11 provides additional summary statistics, Table 12 shows provincial-level coverage, and Table 13 details district-level coverage.

Table 11: Summary of 2019 PMI VectorLink IRS Campaign

Dates of PMI-supported IRS campaign	October 2–November 30, 2019
Total operational days	42
Insecticides used	SumiShield 50 WG (clothianidin) and Fludora Fusion (clothianidin and deltamethrin)
Number of provinces	3 (Copperbelt, Eastern, and Luapula)
Number of districts	20
Number of structures found by SOPs	598,732
Number of structures sprayed by SOPs	536,983
2019 spray coverage	90%
Population protected	2,273,188 (50,100 pregnant women; 318,396 children under 5 years old)
Number of people trained with U.S. Government funds to deliver IRS	2,120 ³

³This included: 1,524 SOPs, 319 team leaders, 171 supervisors, and 106 team leader assistants.

Table 12: Provincial Spray Progress and Coverage

Province	Targeted	Found	Sprayed	Spray Progress	Spray Coverage
Eastern	419,291	413,737	383,183	91%	93%
Copperbelt	144,449	148,647	122,708	85%	83%
Luapula (Nchelenge District)	33,885	36,348	31,092	92%	86%
Total	597,625	598,732	536,983	90%	90%

Table 13: District-level Spray Progress and Coverage

Province	District	Spray Progress	Targeted	Found	Sprayed	Coverage	Population Protected	Children <5 Protected	Pregnant Women Protected
1	Total	91%	419,291	413,737	383,183	93%	1,519,927	216,635	30,098
	Chadiza	79%	22,800	19,773	17,990	91%	64,644	9,757	1,002
	Chipata	95%	120,117	122,297	113,659	93%	472,954	65,920	9,964
	Katete	78%	35,700	28,999	27,804	96%	105,955	15,022	1,831
	Lundazi	93%	76,191	78,344	70,764	90%	297,290	41,612	6,341
	Mambwe	85%	22,215	20,952	18,846	90%	79,020	11,462	1,377
	Nyimba	113%	17,909	21,545	20,247	94%	71,230	10,508	2,099
	Petauke	98%	63,333	67,042	62,257	93%	242,685	35,223	4,360
	Sinda	84%	50,332	44,358	42,484	96%	147,871	21,363	2,383
	Vubwi	85%	10,694	10,427	9,132	88%	38,278	5,768	741
Copperbelt	Total	85%	144,449	148,647	122,708	83%	569,007	73,423	14,847
	Chililabombwe	82%	4,225	5,701	3,459	61%	17,278	2,365	439
	Chingola	94%	8,457	8,695	7,923	91%	39,219	5,497	1,350
	Kalulushi	83%	12,276	11,012	10,220	93%	47,397	6,283	954
	Kitwe	76%	11,516	10,715	8,789	82%	43,055	4,523	732
	Luanshya	69%	6,705	9,219	4,601	50%	23,117	3,286	434
	Lufwanyama	91%	21,933	22,952	19,911	87%	88,098	11,407	1920
	Masaiti	79%	24,209	24,136	19,045	79%	82,936	10,697	1843
	Mpongwe	90%	37,515	38,678	33,603	87%	156,579	20,569	5593
	Mufulira	80%	6,805	6,305	5,464	87%	24,617	3,015	468
Luapula	Ndola	90%	10,808	11,234	9,693	86%	46,711	5,781	1,114
	Total	92%	33,885	36,348	31,092	86%	184,262	28,338	5,155
	Nchelenge	92%	33,885	36,348	31,092	86%	184,262	28,338	5,155
Total	90%	597,625	598,732	536,983	90%	2 273 188	318,396	50,100	

VectorLink Zambia monitored the structures that were found and sprayed and compared this to the target structures on a weekly basis. Table 14 summarizes reasons that structures were not sprayed by province.

Table 14: Reasons for Not Spraying Structures

Province	Structures Found	Structures Sprayed	Structures Not Sprayed	Reasons for Not Spraying					
				Sick	Refused	Locked	Funeral	Adult not Present	Other
Eastern	413,737	383,183	30,554	6%	34%	33%	3%	12%	12%
Copperbelt	148,647	122,708	25,939	5%	29%	38%	1%	15%	12%
Luapula (Nchelenge)	36,348	31,092	5,256	10%	31%	27%	2%	14%	17%

The three most common reasons why structures were not sprayed were: 1) refusal by household owners, (2) locked structures, and 3) adult not present during time of SOP visit. It was observed during the campaign that the main reason why people refused to have their households sprayed was because they did not agree to have their households properly prepared (removal of all household items that can be removed, and covering of large furniture that cannot be removed, before commencement of spray). Additionally the main reason observed why structures were locked or an adult was not present at the time of the SOPs' visit was because community members were not informed about the spray campaign in their community nor were told of expected time of visit by SOPs. Reasons which constitute 'Other' include refusals where no reason was given or the household member was unwilling to share the reason.

6. CHALLENGES, LESSONS LEARNED, AND KEY RECOMMENDATIONS

6.1 CHALLENGES

- All data (spray totals and details) were expected to be entered and synced within 48 hours of spraying. In some instances, this did not happen, for several reasons including:
 - Late delivery of SOP forms from remote sites to respective data centers. This happened in Masaiti, Mpongwe, Lufwanyama, and Lundazi and was due to a lack of vehicles or motor bikes to deliver the forms.
 - Additionally in Lundazi, Mpongwe, and Lufwanyama districts, spray teams camped in remote areas which made it difficult to deliver SOP forms back to the data centers in a timely fashion.
- Supervisors did not pay close attention to details when verifying data for accuracy and correctness. This contributed to a slowdown in data entry by DECs who had to spend a significant amount of time cleaning paper-based data before entering data.
- Supervisors underutilized the Dimagi supervisory checklist application. In most districts (>90%), on average, less than 50% of all required supervisory forms were uploaded according to schedule, during the 2019 IRS implementation period.
- The project reported 18 incidents – 9 in Copperbelt, 7 in Eastern and 2 in Nchelenge. Majority of the incidents recorded involved SOPs losing empty insecticide sachets in the field. The major incidents recorded included:
 - Loss of 138 full sachets during insecticide distribution (one box containing 130 sachets) and IRS implementation (8 sachets)
 - Four data falsification incidents – 3 in Copperbelt and 1 in Nchelenge

6.1.1 COPPERBELT PROVINCE

- Lower than expected spray progress and coverage due to:
 - Inadequate community sensitization and mobilization in the first few weeks of IRS operations led to inadequate household preparation, refusals, and many locked structures.
 - Commencement of the rains led to:
 - Interruption of spray operations
 - Delayed departure of spray teams in the morning
 - Finding locked structures as householders went to till the fields
 - Long travel hours to spray areas due to bad road network accessibility
 - High rate of refusals as householders were reluctant to take their belongings outside.
- Long distances between spray areas, as well as between structures in the rural communities (particularly Lufwanyama, Mpongwe, and Masaiti districts).
- Discrepancies (in some instances, particularly in Lufwanyama, Mpongwe, Masaiti, Luanshya, and Chililabombwe) in the target number of structures as compared to the eligible structures found on the ground as a result of:

- An overestimation of target structures in target communities
- Finding ineligible structures (structures made out of grass and/or iron sheets).
- Incorrect recording of non-sprayed structures and mop-up visits in the first few weeks of the campaign.
- Despite engaging NHCs, high rate of refusals leading to low progress and coverage in Luanshya district particularly in peri-urban areas that seemed to qualify as urban.
- Lack of full participation by health facility EHTs in some urban districts by way of protest over non-payment of stipend by VectorLink, in spite of being on the GRZ payroll.

6.1.2 EASTERN PROVINCE AND NCHELENGE

- Overestimation of structures in communities that were sprayed for the first time in Chipata district.
- Lower than expected progress and coverage in Chadiza district due to inadequate community mobilization in the first few weeks of the campaign.
- High rates of refusals in Nchelenge districts in the urbanized communities.
- Data capture using the Reveal tool proved to be a challenge. The newly-developed Reveal tool, managed by Akros, was deployed for the first time in 2019 IRS campaign, and there were numerous system malfunctions that affected data collection and timely decision-making for supervision purposes. As a result, the team had to rely more on PMT data for these districts, and there were significant gaps between PMT data and the final, clean dataset for all districts using Reveal. In Nchelenge, teams had to spend an extra six days entering data on structures that could not be tagged due to software issues. Additionally, the VectorLink Zambia and HQ team spent an enormous amount of time throughout the campaign collecting information from affected field staff, troubleshooting issues in the field, and checking in with Akros via phone calls and emails to monitor the status of various issues. Below are some specific challenges with the Reveal system that were experienced across all Reveal districts; these challenges persisted for several weeks during the campaign:
 - Unable to enter data on a pre-enumerated structure. TLAs were forced to create new structure points and the Akros team manually matched these new points against pre-enumerated points during data cleaning
 - Slow and at times incomplete syncing in low-connectivity environment
 - Dashboards not updating accurately in real-time; did not originally reflect data captured outside of formal spray areas
 - Structures reverting to yellow / changing color
 - Difficult to isolate bugs in real-time from individual users
 - Additionally, there are 9,688 structure-level visits across all four districts for which some data, including population data, was lost. According to Akros, the devices were cleared before the events fully synced to the server. The location of visits and spray status was maintained, but other structure-level information was lost.

6.2 LESSONS LEARNED

- Collaborative resolutions from VectorLink, PHO, and the NMEP to resolve the challenges encountered helped the project succeed in Copperbelt.
- Enhanced community engagement on household preparation (retraining of spray teams midway through the campaign, including live-fire training, and emphasis on explaining the importance of removing household items to the householders) improved community acceptance of IRS in Copperbelt.
- Imbedding of NHCs in spray teams in Copperbelt led to:
 - Improved community acceptance of IRS

- Easy navigation to all the villages within the target community.
- Involvement of health facility EHTs simplified navigation within a particular catchment area.
- Engaging community-based volunteers as SOPs improved community acceptance of the program and simplified locating of structures within target communities.
- Establishment of camping sites in hard to reach areas reduced travel time to spray areas and increased time spent in the field implementing IRS but led to delays in data entry.
- Deployment of SOPs in smaller vehicles and use of excess bicycles for NHCs at HFCA assisted in accessing hard-to-reach areas and tackling widely dispersed structure formation in Lufwanyama.
- Engaging traditional and sectional leaders in community sensitization and mobilization enhanced the acceptability of IRS in the rural and urban parts of the districts, respectively.
- Collaboration between district spray teams within some provinces improved spray coverage and progress in districts that were struggling in their performance and enabled the districts to complete the campaign on schedule.
- Use of bicycles throughout the campaign in Petauke and towards the end period of the campaign in Lundazi reduced the cost of SOP transport. Community-based IRS however attracts additional start-up costs, especially given that it requires establishment of multiple operations sites.
- Establishment of more than one IRS operations site in large districts such as Nyimba, Petauke, Chipata, Masaiti, Mpongwe, Lufwanyama, Lundazi, and Nchelenge enhanced operational efficiency and adherence to environmental compliance guidelines.
- In some instances, not all the targeted communities/structures were eligible for IRS as they were made out of wooden poles, grass, and/or iron sheets; such communities are better suited for other malaria interventions such as insecticide-treated nets (ITNs).
- Distribution of IRS cards by SOPs, as opposed to mobilizers, reduced mop-up challenges experienced during the 2018 spray season. The use of a pre-printed SOP form code in generating unique IRS structure numbers, as opposed to preprinting of unique IRS structure numbers on IRS cards, helped mitigate duplication of IRS numbers in the Vector Collect database.
- The daily demonstration of insecticide mixing as well as the proper documentation on daily SOP forms by supervisors during morning mobilization proved very useful in mitigating SOPs' errors normally associated with mixing of insecticides and documentation
- The two largest mines in Copperbelt Province, Konkola Copper Mines and Mopani Copper Mines, engaged in joint IRS planning and training with VectorLink. Additionally, Konkola provided training facilities for team leaders and SOPs, which fostered the public-private partnership between the MOH, the mines, and VectorLink.
- The shift from using insecticide bottles in previous campaigns to sachets during the 2019 campaign led to mismanagement of empty sachets by SOPs during field operations.
- The low spray progress recorded during the first few weeks of IRS operations compelled supervisors to increase daily SOP targets, which led to some instances of data falsification.
- Non adherence to standard logistics and warehouse operating procedures led to the loss of one box containing 138 full sachets of insecticides during distribution.

6.3 RECOMMENDATIONS

- Maintain the timing of the spray campaign (early October) before the onset of rainy season by continuing to deploy insecticides with longer residual efficacy.

- Enhance trainings at all levels with primary focus on household preparation and provide guidance on mop-up data capture protocol.
- Incorporate additional quality control via VectorLink central level staff supervising SOP training and conducting “live fire” field simulations, with a primary focus on household preparation.
- Make provisions for SOP forms to move from the operations sites to the data center at least three times a week by hiring motorbikes in districts with multiple sites including camping sites.
- Ensure data quality and assign one supervisor per operations site to verify SOP forms are accurate before authorizing their delivery to the data center.
- Practice prompt escalation and resolution of issues with the Reveal tool to ensure that maps can be loaded, structures can be tagged, and data can be used for real-time decision-making.
- Conduct a hands-on orientation to all supervisors including external supervisors on the VectorLink supervision tools ahead of the spray campaign to enhance supervision, and ensure high spray quality and adherence to safety and environmental safeguards.
- Assign a supervisor at each site to verify data for accuracy and correctness before sending to the data center.
- Incorporate a session during TOTs for the police (focusing on the implication of insecticide theft) and ZEMA (on the implication of the loss of insecticides).
- Continue to display posters depicting the penalty for insecticide theft and data falsification at all operation sites.
- Strengthen training on best warehouse management practices, environmental compliance guidelines for insecticide transportation, and supervision of spray teams to reduce potential incidents.

6.3.1 COPPERBELT PROVINCE

- Engage both influential leaders and NHCs in community sensitization and mobilization to help improve community acceptance of IRS.
- Conduct a capacity building workshop for supervisors and managers, considering the enormous challenges that were experienced in the province this year.
- Address the challenges associated with the three rural districts regarding sparsely spread communities:
 - Establish operations sites in identified hard-to-reach areas to reduce travel time
 - Collaborate with DHOs to use extra bicycles for NHCs to access widely dispersed communities
 - Excise very widely dispersed communities that fall out of the IRS eligibility criteria and advise NMEP to target such areas for ITNs.
- Excise identified ineligible structures from 2020 target (in consultation with NMEP and DHOs).
- Enumerate structures using satellite imagery and verify through ground-truthing in the rural districts (Mpongwe, Masaiti, and Lufwanyama) where overestimation of structures in some communities was common. Enumeration will also help make decisions based on spatial distribution of structures.
- Examine HFCAs to remove peri-urban communities that qualify as urban in the seven urbanized districts. Additionally, remove ineligible structures from the targets.
- Increase engagement of private sector (i.e., through support of insecticide procurement, involvement in trainings and planning meetings). On the Copperbelt, the project will enhance collaboration with mines to foster public private partnership through IRS planning, training, and procurement of insecticides which has been problematic in their previous campaigns and has delayed the start of IRS implementation.

6.3.2 EASTERN PROVINCE AND NCHELENGE

- Continue strengthening partnership between the project and PHO in Eastern Province to enhance supervision at all levels of IRS operations (including community mobilization) and maintain good performance. Continue to collaborate with PHO to coordinate key stakeholders to engage in community mobilization through advocacy meetings. Work with the province to closely monitor and supervise IRS operations at the district level.
- Continuously engage key district (e.g., Nchelenge) stakeholders in IRS “off season” and implement post-spray SBCC at the community-level to build trust and help further reduce refusals.
- Work with Akros to develop a realistic plan to address all system malfunctions that were experienced with the Reveal tool during the 2019 IRS campaign. Furthermore, the tool will be field-tested and the outcome report to be shared with VectorLink Zambia project staff before it is rolled out for used in the 2020 IRS campaign.

ANNEX A: M&E PLAN

#	Performance Indicator	Global Project Indicator	Data Source(s) and Reporting Frequency	Disaggregation(s)	Annual Targets and Results									
					Year 1 [2018]		Year 2 [2019]		Year 3 [2020]		Year 4 [2021]		Year 5 [2022]	
					Target	Result	Target	Result	Target	Result	Target	Result	Target	Result
Objective 1: Implementation of Malaria Vector Control (VC) Interventions														
1.1	Successfully Execute IRS and Other Integrated Malaria VC Activities													
1.1.1	Number and percentage of completed annual country work plans developed and submitted on-time	X	Project records Annually	Country										
1.1.2	Number of eligible structures targeted for spraying		Project records Annually	Country	630,000	630,000	617,000 ⁴	597,625						
1.1.3	Number of eligible structures sprayed with IRS ⁵		Project records Annually	Country	535,500	579,490	524,450	536,983						
1.1.4	Percentage of total structures targeted for spraying that were sprayed with a residual insecticide (Spray Coverage)		Project records Annually	Country	85%	92%	85%	90%						
1.1.5	Number of people protected by IRS		Project records Annually	Country Sex Pregnant women Children <5	2,558,542 1,421,874 Males 1,396,302 Females 89,959 Pregnant women 411,416 Children <5	2,818,176 1,421,874 Males 1,396,302 Females 89,959 Pregnant women 411,416 Children <5	2,505,747 1,421,874 Males 1,396,302 Females 89,959 Pregnant women 411,416 Children <5	2,273,188 1,136,809 Males 1,136,387 Females 50,100 Pregnant women 318,396 Children <5						

⁴This target was later adjusted downward to 597,625 (indicated in the results column), during the campaign, due to several reasons that included excising of ineligible structures

⁵Target based on 85% of estimated eligible structures in indicator 1.1.2

#	Performance Indicator	Global Project Indicator	Data Source(s) and Reporting Frequency	Disaggregation(s)	Annual Targets and Results									
					Year 1 [2018]		Year 2 [2019]		Year 3 [2020]		Year 4 [2021]		Year 5 [2022]	
					Target	Result	Target	Result	Target	Result	Target	Result	Target	Result
1.1.6	Number and percentage of vector control project country programs submitting an EOSR within 45 days after the end of spray (including completing MEP and EMMR)	X	Project Annually	Country										
1.1.7	Number and percentage of IRS country programs that conduct a Post-Spray Data Quality Audit within 90 days of spray completion	X	Data Collection Forms Annually	Country										
1.1.8	Number of Insecticide Treated Nets (ITNs) distributed, by channel		Project Records Annually	Country Channel	N/A	N/A	N/A	N/A						
1.1.9	Number and percentage of countries completing ITN durability monitoring data collection as planned in a given project year	X	Project Records Annually	Country										
1.1.10	Number and percentage of PMI-funded durability monitoring surveys with reports submitted within 90 days of the end of data collection	X	Project Records Annually	Country										
1.2	Strengthen Capacity of NMCPs, VC Personnel, and Other Institutions to Implement and Manage IRS and Other VC Activities													
1.2.1	Total number of people trained to support VC in target areas		Project Training Records Annually	Country VC Intervention Sex Job Function	40% Females	2,006 IRS 542; 27% Females Job Function ⁶	40% Females	9,897 IRS 2,371; 24% Female Job Function ⁷						

⁶ This includes; SOPs (1,564), TLs (295), and Supervisors (147).

⁷ This includes: supervisors (171), mobilizers (7,581), SOPs (1,524), team leaders (319), TLAs (106), DECAs (78), M&E Assistants (45), and storekeepers (73). With the revision of the new PMP that took place in early 2019, new cadres of workers are counted towards this indicator which is why the Y2 results have increased.

#	Performance Indicator	Global Project Indicator	Data Source(s) and Reporting Frequency	Disaggregation(s)	Annual Targets and Results									
					Year 1 [2018]		Year 2 [2019]		Year 3 [2020]		Year 4 [2021]		Year 5 [2022]	
					Target	Result	Target	Result	Target	Result	Target	Result	Target	Result
1.2.2	Total number of people trained to support VC in target areas with USG funds		Project Training Records Annually	Country VC Intervention Sex Job Function	40% Females	2,089 IRS 648; 31% Females Job Function ⁸	40% Females	2,120 IRS 693; 33% Female Job Function ⁹						
1.2.3	Number of people trained during the Master (National) Training and/or IRS Training of Trainers.		Project Training Records Annually	Country Sex Type of Training	40% Females	147 35; 24% Females Type of Training: Training of Trainers	40% Females	171 43; 25% Female Type of Training: Training of Trainers						
1.2.4	Total number of people hired to support VC in target areas.		Project Records Annually	Country VC Intervention Sex Job Function	40% Females	1,893 IRS 565; 30% Females Job Function ¹⁰	40% Females	9,052 IRS 2,148; 24% Female Job Function ¹¹						
1.2.5	Number of VC project training workshops targeting NMCP and other host country staff		Project Training Records Annually	Country Technical Area Job Function	1	4 Technical Area/Job Function ¹²	2	2 Technical Area/Job Function ¹³						

⁸ This includes SOPs (1,564), team leaders (95), TLAs (83), and supervisors (147).

⁹ This includes SOPs (1,524), team leaders (319), TLAs (106), and supervisors (171).

¹⁰ This includes SOPs (1,500), team leaders (247), and supervisors (146) supervisors. With the revision of the PMP, additional groups of workers are counted as part of this indicator definition. For Y2 results and beyond, these additional groups of workers will be counted here.

¹¹ This includes; VectorLink and GRZ seasonal supervisors (171), IEC/BCC mobilizers (6,838), SOPs (1,468), team leaders (304), TLAs (95), DECs (62), M&E Assistants (41), and storekeepers (73).

¹² In Y1, the four Training of Trainers (TOTs) workshops were counted as part of this indicator. With the revision of the PMP that took place in Y2, TOTs no longer count towards this calculation. For Y2 results and beyond, TOTs will no longer be counted.

¹³ One training for NMCP on VectorLink Collect and one training on entomological monitoring for Community Based Volunteers.

#	Performance Indicator	Global Project Indicator	Data Source(s) and Reporting Frequency	Disaggregation(s)	Annual Targets and Results									
					Year 1 [2018]		Year 2 [2019]		Year 3 [2020]		Year 4 [2021]		Year 5 [2022]	
					Target	Result	Target	Result	Target	Result	Target	Result	Target	Result
1.2.6	Number of NMCP and other vector control host country staff who logged into VectorLink Collect		DHIS2 Logs Annually	Country Job Function	2	4 Job Function ¹⁴	5	24 Job Function ¹⁵						
1.2.7	Number and percentage of technical assistance requests to support ITN distribution planning and/or implementation completed on time as planned in a given project year	X	Project Records Annually	Country Tech. Area Channel										
1.2.8	Number and percentage of technical assistance requests to support operational routine monitoring systems for continuous ITN distribution completed on time as planned in a given project year	X	Project Records Annually	Country Channel										

¹⁴ This includes: Provincial Health Officers (3) and NMEP staff (1).

¹⁵ This includes: District Health Officers (20), Provincial Health Officers (3), and NMEP Officers (1).

#	Performance Indicator	Global Project Indicator	Data Source(s) and Reporting Frequency	Disaggregation(s)	Annual Targets and Results									
					Year 1 [2018]		Year 2 [2019]		Year 3 [2020]		Year 4 [2021]		Year 5 [2022]	
					Target	Result	Target	Result	Target	Result	Target	Result	Target	Result
1.3	Environmental Compliance and Safety													
1.3.1	Number of seasonal vector control personnel trained in environmental compliance and personal safety standards in vector control implementation		Project Training Records Annually	Country Sex (# and %) Job Function	40% Females	2,079 561; 27% Females Job Function ¹⁶	40% Females	2,087 697; 33% Female Job Function ¹⁷						
1.3.2	Number of health workers receiving insecticide poisoning case management training		Project Training Records Annually	Country Sex (# and %)	40% Females	31 7; 23% Females	40% Females	0 ¹⁸						
1.3.3	Number of adverse reactions to pesticide exposure documented that resulted in a referral for medical care		Incident Report Forms Annually	Country Type of Exposure	0	0	0	7 Type of Exposure ¹⁹						
1.3.4	Number of SEAs and Letter Reports submitted at least 60 days prior to the commencement of VC campaigns	X	Project Records Annually	Country										
1.3.5	Number and percentage of permanent and mobile soak pits inspected and approved prior to IRS campaigns or before first use		Project Records - PSECAs Annually	Country	50; 100%	50; 100%	48; 100%	51; 100%						
1.3.6	Number and percentage of storehouses inspected and approved prior to IRS campaigns		Project Records - PSECAs Annually	Country Storehouse Type	44; 100%	50; 100% Storehouse Type ²⁰	48; 100%	51; 100% Storehouse Type ²¹						

¹⁶ This includes: SOPs (1,564), team leaders (295), supervisors (147), and storekeepers (73).

¹⁷ This includes: SOPs (1,524), team leaders (319), supervisors (171), and storekeepers (73).

¹⁸ Clinicians were not trained this year but training materials were shared with facilities on poison management.

¹⁹ Occupational exposure involving seven SOPs who experienced itchiness and skin rashes; they were referred to nearby clinics for treatment.

²⁰ Type of storehouse: Operational site

²¹ Type of storehouse: Operational site

#	Performance Indicator	Global Project Indicator	Data Source(s) and Reporting Frequency	Disaggregation(s)	Annual Targets and Results									
					Year 1 [2018]		Year 2 [2019]		Year 3 [2020]		Year 4 [2021]		Year 5 [2022]	
					Target	Result	Target	Result	Target	Result	Target	Result	Target	Result
1.4	Promote Gender Equality in all Facets of Planning and Implementation													
1.4.1	Number and percentage of women hired to support VC campaigns		Project Records Annually	Country Sex (# and %) Job Function	40%	565; 30% Job Function ²²	40%	2,127; 24% Job Function ²³						
1.4.2	Number and percentage of women hired in supervisory roles in target areas for VC activities		Project Records Annually	Country Sex (# and %) VC Intervention Job Function	50% Females	38 (31%) Females IRS Job Function ²⁴	40% Females	22 (25%) Female IRS Job Function ²⁵						
1.4.3	Number and percentage of trainees (permanent and seasonal) who have completed gender awareness training		Project Records Annually	Country Sex (# and %) Job Function	100%	2,370; 100% Job Function ²⁶	100%	2,360; 100% Job Function ²⁷						
1.4.4	Number and percentage of women in senior leadership roles in VectorLink country offices	X	Project Records Annually	Country Sex (# and %)										

²² Includes: SOPs (399), team leaders (70) and Supervisors (42), TLAs (18), DECAs (27) and M&E Assistants (9)

²³ Includes: VectorLink seasonal supervisors (22), IEC/BCC mobilizers (1,398), SOPs (517), team leaders (98), TLAs (19), DECAs (37), M&E Assistants (9), and storekeepers (27). With the revision of the PMP, additional groups of workers are counted as part of this indicator definition and will be counted here for Y2 results and beyond.

²⁴ Includes VectorLink supervisors (38).

²⁵ Includes VectorLink supervisors (22).

²⁶ Includes: 1,564 SOPs, 296 team leaders, 147 supervisors, 73 storekeepers, 72 DECAs, 50 M&E Assistants, 100 washers, 31 clinicians, and 38 PMI VectorLink staff.

²⁷ This includes; SOPs (1,524), team leaders (319), TLAs (106), supervisors (171), storekeepers (73), DECAs (78), M&E Assistants (45), and PMI VectorLink staff (44).

#	Performance Indicator	Global Project Indicator	Data Source(s) and Reporting Frequency	Disaggregation(s)	Annual Targets and Results									
					Year 1 [2018]		Year 2 [2019]		Year 3 [2020]		Year 4 [2021]		Year 5 [2022]	
					Target	Result	Target	Result	Target	Result	Target	Result	Target	Result
1.5	Implement and Support SBCC and Mobilization Activities													
1.5.1	Number of radio spots and talk shows aired		Project Records Annually	Country VC Intervention Talk Show or Radio Spot	495	553 IRS Talks Shows: 0 Radio Spots: 553	540	440 IRS Talks Shows: 20 Radio Spots: 420						
1.5.2	Number of print materials distributed to or targeted at beneficiaries		Project Records Annually	Country VC Intervention	18,820	18,820 IRS	18,432	0 ²⁸ IRS						
1.5.3	Number of people reached with vector control and/or SBCC messages via door-to-door messaging		Project Records Annually	Country VC Intervention Sex	2,558,542	745,454 IRS Males: 353,191 Females: 392,263	NA	NA ²⁹						
2. Entomological and Epidemiological Data to Drive Decision-Making														
2.1	Vector Control Activities Monitored via Entomological and Epidemiological Data													
2.1.1	Number of project-supported entomological sentinel sites established to monitor vector bionomics (vector species, distribution, seasonality, feeding time, and location)		Entomological Reports Annually	Country VC Intervention	14	14 IRS	14	14 IRS						
2.1.2	Number and percentage of vector bionomics monitoring sites measuring all basic entomological indicators (species composition, indoor and outdoor human biting rates, hourly human biting rates, indoor resting densities)		Entomological Reports Annually	Country VC Intervention	14; 100%	14; 100% IRS	14; 100%	14; 100% IRS						

²⁸ With the revision of the PMP, this indicator was revised to count only print materials given to or targeted at beneficiaries. While many print materials were given to traditional and religious leaders, posted at Operational Sites, etc., none were given specifically to beneficiaries, which is why the result is 0.

²⁹ There were a total of 11,234 community meetings that were held by headmen and sectional leaders. Door-to-Door mobilization was not conducted during the 2019 IRS campaign.

#	Performance Indicator	Global Project Indicator	Data Source(s) and Reporting Frequency	Disaggregation(s)	Annual Targets and Results									
					Year 1 [2018]		Year 2 [2019]		Year 3 [2020]		Year 4 [2021]		Year 5 [2022]	
					Target	Result	Target	Result	Target	Result	Target	Result	Target	Result
2.1.3	Number and percentage of vector bionomics monitoring sites measuring the following all advanced entomological indicators: sporozoite rates and entomological inoculation rates		Entomological Reports Annually	Country IRS or Entomology Only Program	14; 100%	14;100% IRS	14; 100%	0 ³⁰ IRS						
2.1.4	Number and percentage of insecticide resistance monitoring sites that tested all priority insecticides for the relevant local vector control intervention		Entomological Reports Annually	Country VC Intervention	16; 100%	16; 100% IRS	14; 100%	4; 28% ³¹ IRS						
2.1.5	Number and percentage of houses in which WHO cone bioassays were conducted within two weeks of spraying with greater than 98% test mortality recorded for IRS countries		Entomological Reports Annually	Country Insecticide Type	NA	NA ³²	42	42; 100% Insecticide Type: 18 (40%) SumiShield 24 (60%) Fludora Fusion						
2.1.6	Number and percentage of sites that conducted WHO cone bioassays after the completion of spraying at monthly intervals until test mortality drops below 80% for two consecutive months for IRS countries		Entomological Reports Annually	Country Insecticide Type	NA	NA ³³	30	30; 100% 12 (40%) SumiShield 18 (60%) Fludora Fusion						

³⁰ With the new PMP revision, this indicator definition has been refined. Thus the results from Y1 may look different than the target and results for the remainder of the project. No sporozoite rate measurements have been taken because of issues with the ELISA reagents.

³¹ With the new PMP revision, this indicator definition has been refined. Thus the results from Y1 may look different than the target and results for the remainder of the project.

³² With the revision of the PMP, this indicator definition changed significantly and results from Y1 cannot be measured against the new indicator definitions. Please refer to the 2018 End of Spray Report for results against the indicator at the time.

³³ With the revision of the PMP, this indicator definition changed significantly and results from Y1 cannot be measured against the new indicator definitions. Please refer to the 2018 End of Spray Report for results against the indicator at the time.

#	Performance Indicator	Global Project Indicator	Data Source(s) and Reporting Frequency	Disaggregation(s)	Annual Targets and Results									
					Year 1 [2018]		Year 2 [2019]		Year 3 [2020]		Year 4 [2021]		Year 5 [2022]	
					Target	Result	Target	Result	Target	Result	Target	Result	Target	Result
2.1.7	Number of countries with an integrated vector control analytics dashboard created by PATH, available for decision-making	X	Project Reports Annually	Country										
2.1.8	Number of people trained (VectorLink and non VectorLink staff) in entomological monitoring		Project Records Annually	Country Sex (# and %)	32 40% Female	24 Males: 16 (68%) Females: 8 (32%)	242 40% Female	213 Males: 166 (78%) Females: 47 (22%)						
2.1.9	Number and percentage of sites in which WHO cone bioassays were conducted to evaluate bio-efficacy of bed nets		Entomological Records Annually	Country	NA	NA	NA	NA ³⁴						
2.1.10	Number of nets in which WHO cone bioassays were conducted to evaluate bio-efficacy of bed nets		Entomological Records Annually	Country	NA	NA	NA	NA ³⁵						

³⁴This indicator did not exist in Year 1; it was introduced as part of the 2019 PMP revision. This indicator was not planned for in 2019.

³⁵ This indicator did not exist in Year 1; it was introduced as part of the 2019 PMP revision. This indicator was not planned for in 2019.

#	Performance Indicator	Global Project Indicator	Data Source(s) and Reporting Frequency	Disaggregation(s)	Annual Targets and Results									
					Year 1 [2018]		Year 2 [2019]		Year 3 [2020]		Year 4 [2021]		Year 5 [2022]	
					Target	Result	Target	Result	Target	Result	Target	Result	Target	Result
2.2	NMCPs Develop Country-Level IRS and Other Malaria VC Strategies													
2.2.1	Number and percentage of countries with an integrated malaria vector control strategy, including a plan for monitoring and managing insecticide resistance supported by the project	X	Project Records Annually	Country										
2.2.2	Number and percentage of countries with a data and visualization dashboard complete for IRS and/or entomology data in VectorLink Collect for vector control decision making	X	Project Records Annually	Country										
2.2.3	Number of countries that implement sub-national insecticide rotation	X	Project Records Annually	Country										
2.3	Build capacity of NMCPs and local institutions to collect, analyze, and use data for strategic malaria control decision-making													
2.3.1	Number of individuals trained from NMCPs and national institutions to review and interpret data for integrated vector control decision making		Project Training Records Annually	Country Job Function Organization	4	9 Job Function/Organization ³⁶	4	5 Job Function/Organization ³⁷						
2.3.2	Number and percent of targeted individuals that report using new analytical tools and/or skills in their planning, resourcing, implementation, or measurement activities		Capacity Assessments Thrice Over Project Life	Country Job Function Organization	4	4 Job Function/Organization ³⁸	4	24 Job Function/Organization ³⁹						

³⁶ NMEP (9)

³⁷ NMEP (5)

³⁸ Participants included: NMEP (3) and MOH (1).

³⁹ This includes: District Health Officers (20), Provincial Health Officers (3), and NMEP Officers (1).

#	Performance Indicator	Global Project Indicator	Data Source(s) and Reporting Frequency	Disaggregation(s)	Annual Targets and Results									
					Year 1 [2018]		Year 2 [2019]		Year 3 [2020]		Year 4 [2021]		Year 5 [2022]	
					Target	Result	Target	Result	Target	Result	Target	Result	Target	Result
3. Procurement and Logistics														
3.1	Cost-Effective Procurement Mechanism Established													
3.1.1	Number and percentage of insecticide procurements that had a pre-shipment QA/QC test, done by a third party, at least 60 days prior to spray campaign	X	Procurement Records Annually	Country Insecticide Type										
3.1.2	Number and percentage of insecticide procurements received on-time to allow for the initiation of spray operations as scheduled		Procurement Records Annually	Country Insecticide Type	2; 100%	2; 100% Insecticide Type: Actellic 300CS, SumiShield	2; 100%	2; 100% Insecticide Type: SumiShield, Fludora Fusion						
3.1.3	Number and percentage of targeted countries with international equipment procurements, including PPE, received on-time to allow for the initiation of vector control campaigns as scheduled	X	Procurement Records Annually	Country VC Intervention										
3.1.4	Number of VectorLink staff trained on procurement	X	Project Records Annually	Country										
3.2	Robust Inventory Management and Logistics Systems Established													
3.2.1	Number and percentage of logistics and warehouse personnel (seasonal and full-time) trained in VC supply chain management		Project Training Records Annually	Country VC Intervention Sex Job Function	65	73 (29% Female) IRS Males: 52 Females: 21 Job Function ⁴⁰	68	73 (37% Female) IRS Males: 46 Females: 27 Job Function ⁴¹						

⁴⁰ This includes: storekeepers (73)

⁴¹ This includes: storekeepers (73)

#	Performance Indicator	Global Project Indicator	Data Source(s) and Reporting Frequency	Disaggregation(s)	Annual Targets and Results									
					Year 1 [2018]		Year 2 [2019]		Year 3 [2020]		Year 4 [2021]		Year 5 [2022]	
					Target	Result	Target	Result	Target	Result	Target	Result	Target	Result
3.2.2	Number and percentage of operations site warehouses where physical inventories can be verified by daily stock records		Inventory and Stock Records Annually	Country	44	50; 100%	48	48; 100%						
3.2.3	Number and percentage of IRS countries that successfully completed spray operations without an insecticide stock-out	X	Inventory and Stock Records Annually	Country Insecticide Type										
4. Innovation														
4.1	Conduct operational research or monitoring to scale up new tools, methods, and approaches													
4.1.1	Number of operational research studies on promising new tools or new methods/approaches to existing tools that are implemented		Project Records Annually	Country Type of Innovation	0	0	0	0						
4.2	Create and share knowledge through dissemination of best practices and lessons learned													
4.2.1	Number of innovations, best practices, and other data or lessons learned shared with other partners or international institutions for global reporting on the Vector Learning Exchange	X	Project Records Annually	Country Technical Area										
4.2.2	Number of individual members who use the Vector Learning Exchange	X	Project Records Annually	N/A										
4.2.3	Number of symposia and/or presentations submitted to and accepted at global conferences		Project Records Annually	Country Technical Area	2	0	2	2						

⁴² Two international poster presentations, in the form of abstract, were made by VectorLink staff in 2019: at the following global conferences: (1) Malaria Research Conference, Pretoria, RSA (2) Annual Meeting of the Pan-African Mosquito Control Association, Yaoundé, Cameroun.

#	Performance Indicator	Global Project Indicator	Data Source(s) and Reporting Frequency	Disaggregation(s)	Annual Targets and Results									
					Year 1 [2018]		Year 2 [2019]		Year 3 [2020]		Year 4 [2021]		Year 5 [2022]	
					Target	Result	Target	Result	Target	Result	Target	Result	Target	Result
4.2.4	Number of success stories written or videos produced and shared on the VectorLink project website		Project Records Annually	Country	5	1	2	2						
4.2.5	Number of peer-reviewed journal articles submitted and accepted	X	Project Records Annually	Technical Area										
4.2.6	Number of contributions to vector control global or country policy and/or guidance documents		Project Records Annually	Country Technical Area	1	1 ⁴³ Technical Area: MOP	1	2 ⁴⁴						
4.3	Develop and deploy cost-savings approaches													
4.3.1	Number of innovative or novel approaches implemented to achieve cost savings in IRS and integrated malaria vector control programs		Project Records Annually	Country VC Intervention	1	1 IRS	1	1 ⁴⁵ IRS						
4.3.2	Number of cost effectiveness assessments of existing approaches in the implementation of IRS and integrated malaria vector control programs		Project Records Annually	Country VC Intervention	1	1 IRS	1	0						

⁴³ Per the indicator definition in the first version of the project PMP, the Malaria Operational Plan fulfilled this requirement. The project also contributed substantially, through the integrated data analytics and visualization activity, to the country's Technical Advisory Committee Meeting in 2020, which led to the selection of the insecticides to be used in the 2020 campaign.

⁴⁴ VectorLink Zambia supported the country's National Malaria Elimination Program to use data to guide the IRS insecticide choice for 2020 IRS campaign.

⁴⁵ Community-based IRS was piloted in Petauke district in 2019.

#	Performance Indicator	Global Project Indicator	Data Source(s) and Reporting Frequency	Disaggregation(s)	Annual Targets and Results									
					Year 1 [2018]		Year 2 [2019]		Year 3 [2020]		Year 4 [2021]		Year 5 [2022]	
					Target	Result	Target	Result	Target	Result	Target	Result	Target	Result
4.4	Cultivate public-private partnerships													
4.4.1	Number of private sector entities engaged with to establish public private partnerships to increase the quality and coverage of malaria vector control activities globally		Project Records Annually	Country	1	0	3	2 ⁴⁶						

⁴⁶ (1) PMI VectorLink used mine facilities (Konkola Copper Mines) for training of team leaders and SOPs in two districts, (2) Mopani and Konkola Copper Mines staff attended both microplanning and TOT meetings on the Copperbelt

ANNEX B: 2019 ENVIRONMENTAL MITIGATION AND MONITORING REPORT

Mitigation Measure	Status of Mitigation Measures	Outstanding issues relating to required conditions	Remarks
1a. Pre-contract inspection and certification of vehicles used for pesticide or spray team transport.	Conducted from September 9 to 13, 2019. Some trucks presented for inspection did not have benches or railings, or complete documentation. Other vehicles were not roadworthy. In total, 124 vehicles were inspected, and 72 were hired.	None.	After the inspections, all suitable trucks were retrofitted with benches, tents, roll cages, and handrails. Vehicles that were not roadworthy were not hired.
1b. Driver training	Trained 72 drivers between September 28 and 29, 2019 across all districts.	None.	VectorLink individually oriented all drivers who joined mid-campaign on the safeguards for SumiShield and Fludora Fusion and spray team transport.
1c. Cell phone, personal protective equipment (PPE), and spill kits on board during pesticide transportation.	All drivers were required to have cell phone and were given PPE after training. Transport vendors provided each vehicle with a first aid box and spill management kit.	None.	Vendors stocked all vehicles with complete spill kits and first aid kits to last the whole spray campaign after VectorLink staff emphasized this requirement for all vehicles.
1d. Initial and 30-day pregnancy testing for female candidates for jobs with potential pesticide contact.	SOPs, washers, and store assistants took initial pregnancy tests before they were hired. The tests were done between September 16 and 20, 2019. A second test was conducted 30 days after the first round of tests. No female was found pregnant during both tests that were conducted in all districts.	None.	None.
1e. Health fitness testing for all SOPs	All SOPs received medical examinations (physical examinations, Hb, and blood pressure tests) before they were hired.	None.	None.
1f. Procurement of, distribution to, and training on the use of PPE for all workers with potential pesticide contact.	Both international and local procurements were completed before trainings began. The use of PPE was demonstrated during TOTs, cascade, and storekeeper trainings before the spray campaign began.	None.	None.

Mitigation Measure	Status of Mitigation Measures	Outstanding issues relating to required conditions	Remarks
1g. Training on mixing pesticides and the proper use and maintenance of spray pumps.	All trainings covered the correct mixing procedure for pesticides, including SOP and home owner safety. Some trainings covered maintenance of the sprayers; 171 supervisors were trained during TOTs, and 319 team leaders were trained during team leader training. Out of the 198 house owner and SOP performance inspections submitted, three instances of leaking pumps were reported and no report was submitted on incorrect mixing of insecticide.	None.	At the beginning of the spray campaign (after training), a few SOPs still could not properly clean and assemble the sprayers. District coordinators and supervisors reviewed this procedure with them daily during morning mobilization, which helped to minimize the number of leaking pumps. Team leaders were available in the field to ensure that faulty sprayers were immediately replaced or fixed.
1h. Provision of adequate facilities and supplies for end-of-day clean-up.	All 51 IRS operations sites (fixed and campsites) were located within health center premises. 34 new IRS operations sites with storerooms and soak pits were established. Access to all stores was limited to authorized IRS staff. In addition, 20 MSPs were provided before the campaign. According to BMP guidelines, VectorLink staff and MOH supervisors did 77 end-of-day clean-up inspections of fixed and MSPs; all operations sites inspected had wash facilities with soap and water for SOPs.	None.	All operations sites had wash facilities with adequate water, soap, buckets, and privacy. The camping sites had temporary wash facilities that were certified prior to the start of the spray campaign. In districts without running water, washers drew and reserved water from the borehole before SOPs returned from the field, for use in end-of-day clean-up.
1i. Enforce clean-up procedures.	Sprayer clean-up was done in designated wash areas and supervised by the environmental compliance officer (ECO), IRS managers, district coordinators, and other PMI VectorLink staff. PMI VectorLink staff and MOH supervisors inspected 51 sites (77 total inspections) and reported three cases of non-compliance.	None.	Early in the campaign, team leaders did not take time to supervise the end-of-day clean-up activities. PMI VectorLink staff that visited all 20 districts addressed the issue by providing feedback and disseminating text reminders through the CommCare system.
2a. IEC campaigns to inform homeowners of responsibilities and precautions.	The project trained 7,574 headmen and section leaders to conduct community meetings and door-to-door community mobilization and sensitization on IRS to inform homeowners what to do before, during, and after spray. All districts conducted radio programs as part of the IEC campaign.	None.	Community mobilization using headmen, section leaders, and neighborhood health committee members informed communities on precautions and responsibilities.

Mitigation Measure	Status of Mitigation Measures	Outstanding issues relating to required conditions	Remarks
2b. Prohibition of spraying houses that are not properly prepared.	SOPs were advised not to spray in structures that were not properly prepared. PMI VectorLink and MOH staff did 198 homeowner preparation and SOP performance inspections. Early in the campaign, there was only one report of a structure sprayed without adequate preparation.	Inadequate house preparation in farm blocks and urban areas	In both urban and farm blocks, household preparation remains a challenge due to the large number of household items (e.g., maize) that have to be removed and in most cases past experiences of how home preparations were done. This led to refusals. Retraining of spray teams on correct household preparation with live field demonstrations in some districts improved communities' acceptance.
2c. Two-hour exclusion from house after spraying.	SOPs were trained to tell homeowners to keep windows and doors of sprayed structures closed for two hours, and then open them to circulate air for at least 30 minutes before cleaning floors. The ECO, district coordinators, and supervisors played a pivotal role in enforcing this requirement. As a result, all 198 inspections revealed SOPs had informed household owners about post-spray procedures.	None.	None.
2d. Instruct homeowners to wash itchy skin and go to health clinic if symptoms do not subside.	Homeowners were instructed to wash their skin with plenty of water and soap if they experienced itching and to visit the nearest clinic if the itching persisted. Out of 198 inspections, there was only one instance of a structure being sprayed without giving post-spray instructions to the residents.	None.	Most SOPs provided the required information to homeowners, but some homeowners forgot the instructions. However, these instructions were repeated by PMI VectorLink and MOH staff doing monitoring and supervision.
3a. Indoor spraying only.	The ECO, district coordinators, team leaders, and supervisors worked hard to ensure all sprayable surfaces were sprayed, including the walls, ceiling, and eaves of all sleeping spaces. As a result, all 198 inspections showed that SOPs were only spraying the recommended surfaces.	None.	None
3b. Training on proper spray technique.	Team leaders and SOPs in all the districts were trained on proper spray techniques from September 9–30, 2019. The 198 inspections found only one instance of SOP non-compliance.	None.	During the first week of spraying, SOPs who were new hires were not consistent with the spray techniques and were retrained during morning mobilization to bring them up to standard with the spray technique. As the campaign progressed, spray technique was no longer an issue.

Mitigation Measure	Status of Mitigation Measures	Outstanding issues relating to required conditions	Remarks
3c. Maintenance of pumps.	Prior to the deployment of SOPs each morning, team leaders and supervisors serviced all spray pumps. Out of 198 inspections, one leaking pump was found. However, the team leaders and supervisors were always in the field to repair the defective pumps so that SOPs could quickly resume work.	None.	None.
4a. Choose sites for disposal of liquid wastes, including mobile soak pit sites according to PMI BMPs.	Selecting the soak pit sites for liquid waste disposal was jointly done by the ECO, Zambia Environmental Management Agency (ZEMA), and MOH Provincial and district representative and was supervised by the project Chief of Party in accordance with the PMI BMP. Fifty-one fixed soak pits and 20 MSPs that were properly sited were used during the 2019 IRS campaign. Inspections of MSP sites reported no badly selected MSP sites, nor did the PSECA.	None.	All sites selected for both fixed and mobile soak pits were suitable for the disposal of liquid waste.
4b. Construct fixed and mobile soak pits with charcoal to adsorb pesticide from rinse water.	Thirty-four ⁴⁷ new soak pits were constructed according to BMP design. Construction was supervised by the ECO, district coordinators, and MOH district representative and had to be approved by the ZEMA. ⁴⁸ In addition, 22 MSPs (14 in Lundazi, 4 in Mpongwe, and 4 in Lufwanyama) were used in areas where the distances from the operations site were significant.	None.	The use of MSPs reduced the costs and compliance issues associated with long distances between the fixed IRS operations site and spray sites. MSPs also expedited end-of-day clean-up. At the fixed soak pits, end-of-day clean-up was expedited by setting two sets of seven rinse barrels each to avoid congestion at the soak pit.
4c. Maintain soak pits as necessary during season.	Twenty MSPs filled with granular activated charcoal were built and installed in three districts where SOPs camped.	None.	None.
4c. Maintain soak pits as necessary during season.	Fifty-one fixed and 20 mobile soak pits were well-maintained. Contaminated water drained properly into the soak pits.	None.	None.

⁴⁷ 15 on the Copperbelt, 18 in Eastern Province, and 1 in Nchelenge.

⁴⁸ VectorLink provided 61 MSP IIs as part of technical assistance to NMEP to mitigate liquid waste disposal in areas where they were spraying with DDT

Mitigation Measure	Status of Mitigation Measures	Outstanding issues relating to required conditions	Remarks
4d. Inspection and certification of solid waste disposal sites before spray campaign.	The ECO, chief environmental health officer, and the PMI VectorLink operations manager inspected solid waste disposal sites before the spray campaign started.	None	Most dump sites in Zambia are not properly managed and thus scavenging is common. To prevent this, VectorLink washes and gives uncontaminated waste (old overalls, bags, and used mutton cloths, helmets) to deserving SOPs. Worn-out face shields and gloves will be washed, then shredded and buried at the dump site. Contaminated boxes, empty insecticide sachets, and nose masks will be incinerated at the UTH; uncontaminated boxes will be given to paper milling plants as raw material in paper production.
4e. Monitoring waste storage and management during campaign.	All IRS solid waste was separated into categories (paper, plastic, rubber, and cloth, and were stored in labeled refuse bags. The 76 storekeeper performance inspections conducted found one instance where containers for empty sachets and used masks unaccounted for or not labeled.	None	Most storekeepers (86%) were new to the program which made it difficult for them to adhere to the PMI BMP guidelines. Since, the entire VectorLink Zambia management team was in the field monitoring and supervising IRS operations throughout the campaign, they were able to immediately identify and correct many non-compliance issues.
4f. Monitoring disposal procedures post-campaign.	The ECO will monitor the post-spray campaign solid waste disposal. All IRS waste has been collected and transported to the Lusaka Cleansing Depot for disposal at the national dump site. UTH will incinerate contaminated wastes (such as used nose masks, sachets) by January 2020.	None.	None.

Mitigation Measure	Status of Mitigation Measures	Outstanding issues relating to required conditions	Remarks
5a. Maintain records of all pesticide receipts, issuance, and return of empty sachets/bottles.	Stock cards tracked pesticide going to and from the central store, with back-up ledger books at central, district, and sub-district stores. Additionally daily insecticide tracker, serialized insecticide tracking log at district and sub district tracked pesticide given out daily. The 76 storekeeper performance inspections conducted found no instance when the sum of the stock balance on the stock card, the stock issued for the day, and the balance of empty sachets/bottles did not equal the opening balance in the ledger.	None.	Since most storekeepers had not worked in previous IRS campaign/s, instances of lapses in adherence to regular inventory counts were observed. VectorLink Zambia staff were in the field to monitor and supervise IRS operations throughout the campaign rectified this anomaly and helped to limit environmental compliance violations in IRS stock management. Incident reports of missing empty/ full insecticide sachets were recorded in some district stores. Store keeper training will need to be revised to address this matter.
5b. Reconciliation of number of houses sprayed vs. number of sachets/bottles used.	The average number of structures sprayed per bottle of insecticide was lower than the estimated average of 3.9.	None.	VectorLink sprays urban and rural areas and, in some catchment areas, households have very big structures. One bottle can therefore protect fewer structures.
5c. Visual examination of houses sprayed to confirm pesticide application.	Visual examination of houses sprayed was conducted by observing the traces of the sprayed chemical of the walls, ceilings, and eaves during data collection verification by supervisors, district coordinators, M&E assistants, and other PMI VectorLink staff.	None.	None.
5d. Perform physical inventory counts during the spray season.	The ECO, district coordinators, and logistics coordinator did physical inventory counts during and after the spray season with the storekeeper performance inspection checklist. In 76 inspections, the balance on stock cards equaled the physical stock.	None.	Store keepers were able to correctly use stock control cards and daily insecticide usage registers and they made no errors in entries. This was after some storekeepers were reoriented on correct IRS stock management.