PAPER 8

A PRACTICALLY APPLIED, HOLISTIC APPROACH TO VANDALISM PREVENTION

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ABSTRACT

Vandalism may be one of the biggest problems facing South African infrastructure. If one does not attend to repairing the social fabric holistically, South Africa's infrastructure will eventually be stripped bare. Anything less than an overall societal approach merely provides a band-aid when open-heart surgery is required. The breakdown of social fabric and the socio-economic factors faced by many people include, but is not limited to, inequality, the cycle of poverty, and drug abuse. While the big all-encompassing solutions to fixing the social fabric are the focus of national government, municipalities need to protect their assets as best they can to ensure they can still provide basic services. Community engagement is vital in building trust, educating communities, and preventing vandalism and theft.

South Africa, being a water-scarce country, is regularly faced with droughts. This occasionally causes intermittent, or extended water supply failures. Millions of litres of water can be lost through vandalism on critical infrastructure which in turn leads to further downtime for emergency repairs, which are costly. It should be noted that failures due to criminality on critical infrastructure is a separate cause of basic needs supply failures.

Historically, vandalism denoted damage just for the sake of doing damage, however the phrase has developed to include theft, malicious damage to property and other related crime. Criminals have monopolized the availability of an income stream through the like of illegal scrap yards and most damage to water infrastructure criminality. Ultimately, a person who is intent on committing crime, if given enough time or the correct tools will be successful. The key to the prevention of vandalism may lie in being a step ahead of alleged vandals, although physical vandalism prevention is only as effective as the security response to alarms. The response must be prompt and have a zero-tolerance approach with respect to the law.

This paper explores the implementation of systems not only for water, but electricity, roads, and other utility infrastructure. It includes suggestions for physical measures to delay vandalism, and some examples from pilot projects where vandals are reaching a point of failing to intrude. Furthermore, it includes community engagement concepts to promote a sense of ownership of utility infrastructure. This leads to the interrogation of the market for stolen infrastructure, and the requirements for supporting services such as security. How to bring ownership of infrastructure to the people's door is the key question.

1. INTRODUCTION

Criminal acts may be one of the biggest contributing factors to infrastructure failure in South Africa. South Africa's most critical infrastructure for electricity, water and other utilities can be crippled to such an extent that municipalities are not able to provide basic services to its citizens. Traffic intersections are left dysfunctional and unsafe due to cable theft, stolen controllers or UPS systems and wastewater contaminating rivers and streets and-so-forth.

Costs are incurred wherever vandalism has been committed, however vandalism may have further reaching impacts than the mere cost of repairing the vandalism. The funding, which is spent on repairing the vandalism, could have been spent on other high priority services. It has become paramount to evaluate the conventional systems, materials, and respective alternatives to prevent the reoccurrence of vandalism.

The South African crime statistics for the fourth quarter presents year-on-year increases in most instances apart from the category, "crime detected as a result of police action." This indicates a lack of police action for crime detection and prevention. As such, the missing link in the chain of vandalism and theft prevention could be reduced to one of lack of policing of critical infrastructure.

FIGURE 1: *Burst as a result of a stolen air valve*

FIGURE 2: *Repaired and secured chamber*

January to March 2022							
CRIME CATEGORY	**January to March 2018**	**January to March 2019**	**January to March 2020**	**January to March 2021**	**January to March 2022**	**Count Diff**	**% Change**
CONTACT CRIMES (CRIMES AGAINST THE PERSON)							
Murder	4,668	4,896	4,589	4,976	6,083	1,107	**22.2%**
Sexual Offences	12,275	13,801	12,627	12,133	13,799	1,666	**13.7%**
Attempted murder	4,243	4,647	4,216	4,582	5,717	1,135	**24.8%**
Assault with the intent to inflict grievous bodily harm	41,078	43,113	40,168	36,417	42,992	6,575	**18.1%**
Common assault	39,314	42,262	42,866	38,889	45,746	6,857	**17.6%**
Common robbery	12,225	12,667	12,262	9,549	10,787	1,238	**13.0%**
Robbery with aggravating circumstances	31,864	33,130	33,404	30,768	32,783	2,015	**6.5%**
Total Contact Crimes (Crimes Against The Person)	**145,667**	**154,516**	**150,132**	**137,314**	**157,907**	**20,593**	**15.0%**
Total Sexual Offences							
Rape	9,695	10,792	9,905	9,518	10,818	1,300	**13.7%**
Sexual Assault	1,793	2,072	1,913	1,910	2,165	255	**13.4%**
Attempted Sexual Offences	500	610	497	433	547	114	**26.3%**
Contact Sexual Offences	287	327	312	272	269	-3	**-1.1%**
Total Sexual Offences	**12,275**	**13,801**	**12,627**	**12,133**	**13,799**	**1,666**	**13.7%**
SOME SUBCATEGORIES OF AGGRAVATED ROBBERY							
Carjacking	3,828	3,883	4,303	4,513	5,402	889	**19.7%**
Robbery at residential premises	5,183	5,343	4,916	5,288	5,267	-21	**-0.4%**
Robbery at non-residential premises	4,463	4,549	4,741	4,872	4,700	-172	**-3.5%**
Robbery of cash in transit	50	40	47	42	53	11	**26.2%**
Bank robbery	1	1	0	1	5	4	**400.0%**
Truck hijacking	254	245	284	354	465	111	**31.4%**
CONTACT-RELATED CRIMES							
Arson	840	946	853	732	910	178	**24.3%**
Malicious damage to property	26,836	27,911	26,106	24,850	28,649	3,799	**15.3%**
Total Contact-Related Crimes	**27,676**	**28,857**	**26,959**	**25,582**	**29,559**	**3,977**	**15.5%**
PROPERTY-RELATED CRIMES							
Burglary at non-residential premises	17,490	17,623	18,384	15,215	14,241	-974	**-6.4%**
Burglary at residential premises	57,287	55,311	51,004	40,568	40,960	392	**1.0%**
Theft of motor vehicle and motorcycle	12,284	11,813	11,163	9,240	9,377	137	**1.5%**
Theft out of or from motor vehicle	31,238	30,785	27,810	20,111	20,457	346	**1.7%**
Stock-theft	7,673	7,433	6,853	6,089	6,243	154	**2.5%**
Total Property-Related Crimes	**125,972**	**122,965**	**115,214**	**91,223**	**91,278**	**55**	**0.1%**
OTHER SERIOUS CRIMES							
All theft not mentioned elsewhere	75,620	74,533	69,556	59,646	65,920	6,274	**10.5%**
Commercial crime	19,218	21,225	20,193	22,558	25,431	2,873	**12.7%**
Shoplifting	14,768	15,197	14,412	11,597	10,292	-1,305	**-11.3%**
Total Other Serious Crimes	**109,606**	**110,955**	**104,161**	**93,801**	**101,643**	**7,842**	**8.4%**
Total 17 Community Reported Serious Crimes	**408,921**	**417,293**	**396,466**	**347,920**	**380,387**	**32,467**	**9.3%**
CRIME DETECTED AS A RESULT OF POLICE ACTION							
Illegal possession of firearms and ammunition	4,071	3,854	3,607	3,184	3,542	358	**11.2%**
Drug-related crime	82,456	41,810	43,344	35,932	42,309	6,377	**17.7%**
Driving under the influence of alcohol or drugs	19,354	19,657	19,330	8,583	11,992	3,409	**39.7%**
Sexual Offences detected as a result of police action	1,774	2,389	2,377	2,335	2,308	-27	**-1.2%**
Total Crime Detected As A Result Of Police Action	**107,655**	**67,710**	**68,658**	**50,034**	**60,151**	**10,117**	**20.2%**

FIGURE 3: *The South African crime statistics for the fourth quarter 2021/22 period*

The National government and municipalities need to ensure that our national key points are secure, but also to ensure economic development. "Kuznets' inverted-U hypothesis implies that economic growth worsens income inequality first and improves it later at a higher stage of economic development." (Anser, et al., 2020) Furthermore, "Income inequality and unemployment rate increases crime rate while trade openness supports to decrease crime rate." (Anser, et al., 2020) So as affluence increases the mode of criminality may alter but generally when people have enough money to survive, there is no need for criminality. Getting over this hump in economic development is key to the improvement of crime rates. The widespread economic reform is one which must be driven from National Government.

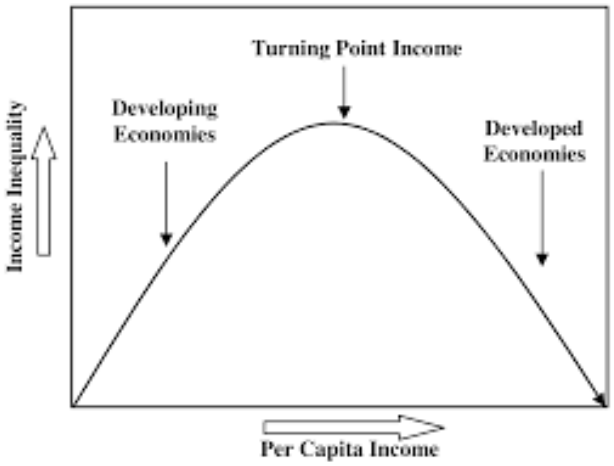

FIGURE 4: *Kuznets inverted U curve hypothesis*

2. NELSON MANDELA BAY MUNICIPALITY (NMBM)

a. Vandalism

Water, electricity, and other utility infrastructure are being targeted in NMBM. Regularly substations are vandalised completely, roads are destroyed by violent protests tantamount to rioting, water pipeline air valves are stripped while under pressure resulting in a massive burst. At the start of 2020 an air valve was vandalised in Motherwell, Gqeberha.

FIGURE 5: *Vandalism by arson*

FIGURE 6: *Malicious vandalism – rock filled chamber*

Exacerbating circumstances included land invasion over the pipeline servitude and a spiderweb of illegal electricity connections which had to be safely disconnected for plant to get to site. The servitude holds the two pipelines coming in from Nooitgedagt WTW. They operate at pressure up to 13 bar and transfer an average of 180Ml/d. The vandalism on the air valve resulted in a critical failure of the base plate. The risk of reoccurrence if no mitigation was done was deemed severe and likely. This initiated a program to replace all the old fittings in that area and secure the chambers to prevent an event of reoccurrence. There have been numerous major water supply failures on other pipelines as a direct result of vandalism. The trial program was successful, and the NMBM bulk water supply division is implementing the measures throughout its bulk water supply system.

b. Drought

Nelson Mandela Bay Municipality has several water supply sources. Historically the municipality has relied on the major dams along the Western coast, specifically, Churchill and Impofu Dams, and Kouga and Loerie Dams, on the Kromme and Kouga catchments, respectively. The catchment areas have been experiencing a drought for several years and as a result the dam levels have reached critical, near dead storage levels. In some cases, the dams have been drawn to dead storage level and an emergency pumping barge has been implemented to abstract below the dead storage levels. When these Western sources run dry there is a scheme in effect which replaces the deficit.

c. Nooitgedagt water supply scheme

The current major source of water for the NMBM is from the Orange River Water Transfer Scheme. The system transfers water through a series of pipelines and canals, ultimately arriving at the Nooitgedagt Water Treatment Works. The plant produces approximately 180Ml/d as at July 2022, and will soon be producing more than 210Ml/d. The water is transferred through two approximately 45km long pipelines to Motherwell reservoir and pump station. From Motherwell it traverses across the metro from east to west until it reaches the Chelsea reservoir, supplying various other areas along the way. From Chelsea reservoir it can be transferred into the Western source pipelines to supplement or replace the deficit in supply from said sources.

d. Volume of water lost in a burst

The Nelson Mandela Bay Municipality Bulk Water Supply division has pipes which fall within the following limits:

- Most of the air valves and scour valves on the Bulk Water Supply system of NMBM are between 100mm and 250mm valves.

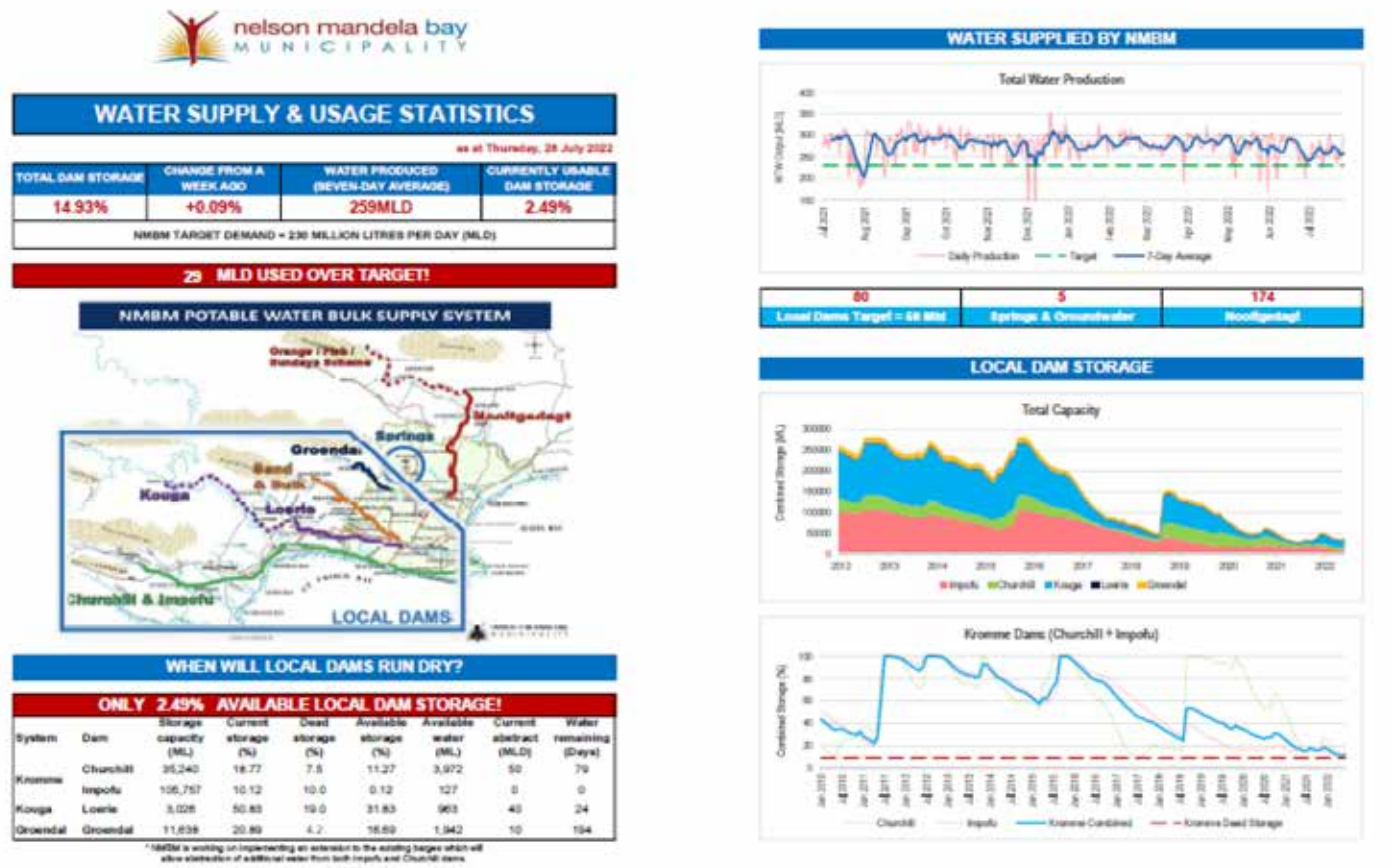

FIGURE 7: *NMBM Water supply & usage statistics as at 28 July 2022*

- Most of the pipelines range from 450mm diameter up to 1400mm diameter.
- The operating pressure in the pipelines ranges between 10 and 25 bar.

The NMBM has implemented a bulk metering program which caters for automated water balance reports. Alternatively, one can estimate the total volume of water lost due to the burst

- The volume of water lost from the time of the burst event until isolation.
- Determine the volume of water scoured

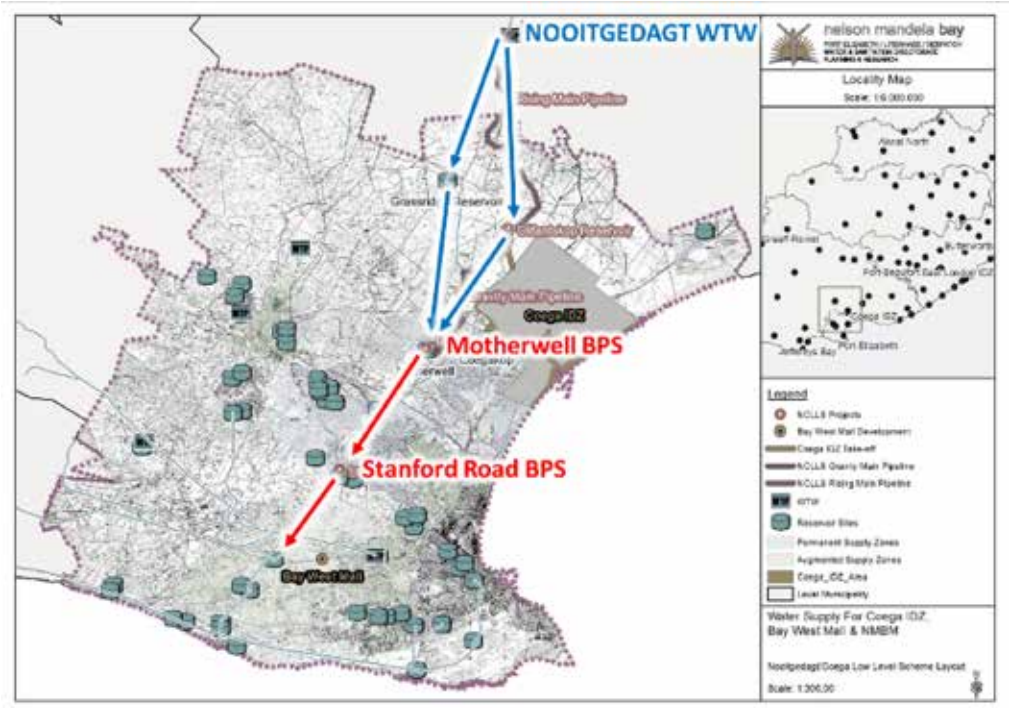

FIGURE 8: *Locality map of the Nooitgedagt water supply system*

3. MAIN PROBLEM STATEMENT AND IDENTIFICATION

The main pipelines that will supply over 70% of the city may become compromised due to water shortages and vandalism. They are a high-risk asset of the Municipality. It is vital that the security and addressing the damage to critical infrastructure be prioritized and maintained accordingly, especially through this period of water shortages. A holistic approach is required to combat the malicious damage and theft of critical infrastructure.

a. Scrap metal market

The municipality has a responsibility to deliver services and must work around problems that are not within their mandate. Engineers must constantly adapt to our changing world. Continually implementing designs which have already been circumvented could be considered tantamount to planning for vandalism. No-scrap-value materials should replace all easily removable valuable components such as manhole lids. This must be coupled with adequate support services. A topic, not discussed herewith, is scrutiny of the illegal scrap metal market and what further action must be taken to address the criminality. It is, however, the responsibility of government to regulate and enforce laws pertaining to the scrap metal market.

FIGURE 9: *Attempted cable theft causes water disruption*

FIGURE 10: *Non-ferrous material lid abandoned outside scrap yard*

b. Security

In 2021, a contractor was nearing completion of a one-day chamber replacements project in Motherwell. The job continued after normal operating hours in a remote area. The teams were allegedly attacked at gun point and tied up with wire. Fortunately, they escaped with their lives. Unnamed security contractors have refused to do protection jobs in high-risk areas because the weapons allegedly further attract gang interests. Both municipal and contracted work teams have allegedly been attacked and robbed on numerous occasions. Tragically, the NMBM has endured staff fatalities due to criminal acts perpetrated against them while on duty. These alleged attacks have led to entirely new operating procedures whereby in the event of a burst at night or in a high-risk area, as many vehicles and staff that can attend do so. All these extra precautions that must be taken for the safety of the staff create a long response time. This makes the municipality appear less competent than they are, which causes distrust.

4. SOLUTIONS

a. Holistic response

"The broken windows theory, (an) academic theory proposed by James Q. Wilson and George Kelling in 1982 that used broken windows as a metaphor for disorder within neighbourhoods. Their theory links disorder and incivility within a community to subsequent occurrences of serious crime." (McKee, 2018)

The broken windows theory can be applied to criminality on critical infrastructure. A public perception needs to be created whereby it is known that the Municipality has patrols, regularly checks its infrastructure, repairs it timeously, etc all in effort of creating a full circle response.

Engineered solutions ensure maximum security by delaying and alerting security services of intrusion. Some engineered solutions are discussed under section 5: Case Study

Although, one of the problems with improved security is that it may only divert the criminality toward less secure targets. One needs to think on all platforms from Roads, Water, sanitation and electrical. These are our fundamental basic needs to live by daily and are failing due to criminal elements.

5. CASE STUDY: VANDALISM ON THE NOOITGEDAGT SUPPLY PIPELINES

The Nooitgedagt supply pipelines traverse through some high safety risk areas. There have been many different methods that criminals have used to break in and steal or vandalise components within the structure. The bulk water supply division has responded to all intrusion attempts by analysing the modes and implementing measures to render future attempts fruitless.

a. Internal chamber braces:

- Problem statement: It was found during intrusion testing that a small gang of thieves would be able to move the concrete slabs using crowbars.
- Solution: Prevent intrusion by internally fastening the chamber together, preventing lifting, moving or separation of the cover slab or rings with crowbars or similar tool. Strap the joints internally to prevent the movement of slabs from the outside.
- Methodology: Steel straps to fasten two rings, or a ring and cover slab together.
- Cut 200mm long sections of flat bar for ring-ring joints.
- Cut sections 100x100 angle iron.
- Width and thickness can be 50mm and 5mm or more respectively.
- Corrosion protection to ensure longevity
- Fasteners to secure the braces to the chamber.
- Tools: grinder to cut steel, drill with steel bit and masonry bit, chalk marker, generator
- Cost effective solution and it can be implemented by municipal staff.

FIGURE 11: *Unbraced cover slab collapse due to an intrusion attempt*

FIGURE 12: *installation of internal chamber braces*

b. Double chambering:

- Consideration: Criminals break through chambers that have thin walls such as rings.
- Solution: Reinforce chamber walls and cover slabs.
- Methodology: Construct a larger chamber around the chamber in question and fill the gap with mass concrete. This provides triple physical protection against chamber destruction.
- Cost effectiveness: This option is more expensive than brackets, but much more secure. One could backfill rubble or in-situ materials to save on the cost of concrete mass fill.

c. Cover slabs:

- Consideration: Placing obscure cover slabs over chambers has been found to be ineffective.
- Solution: Ensure that all chambers are secure with effective cover slabs.
- Methodology:
  - Reinforced concrete cover slabs must be of the exact outside dimensions of the chamber
  - Any gaps should be sealed.
  - The cover slabs must be secured from the inside using braces
  - Every chamber which contains a working part in it must have an access manhole.
- Cost effectiveness: Complete replacement of cover slabs can be costly, repairing of the slab is possible in most instances. One would drill and anchor replacement reinforcing, box the shape and cast concrete on site.
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d. Manhole lids:

Consideration: Steel lids may be stolen due to their high scrap metal value.
Solution: Curbing the illegal-market resale of metals, non-ferrous utility access hole covers to be installed.
Methodology:

- There are drop-in products available which require little- to no modifications.
- Other options that require a new frame can be retrofitted by casting a box with the new frame atop the old frame with steel reinforcing and anchor bars which bind the existing slab to the new repair slab.
- Where there is no slab or the slab is beyond economical repair, a new slab will have to be cast.

Cost effectiveness: Ensuring that all chambers have suitable lids can vary in cost from basic replacement to complete new cover slabs.

NMBM Bulk Water Supply has started implementing:

- Manhole lid material: Sheet moulded compound grp, 40 layers – no scrap value – prevents destruction for profits of illegal scrap metal sale. Does not crack after severe abuse such as fire and repeated blows.
- Internal deadbolt powered by an RFID key and a highly sprung mechanical lock prevents the layman from forcing the lock open

FIGURE 13: *Double chambering internal view*

FIGURE 14: *Double chambering external view*

FIGURE 15: *Replacement cover slab with smart manhole*

FIGURE 16: *Repaired chamber*

- RFID access key assigned to staff user that is authorized.
- User access controlled with integrated web-based application.

e. Policing, alarms, and security:

Those listed above, and other physical measures of access control may only delay a person intending on intruding. Given the correct tools and sufficient time that person would be successful. As such, alarms, response security and regular policing are the critical element to complete the circle.

- Regular policing is imperative to crime prevention and detection.
- Concealed traps such as pepper spray systems should be in place as the last measure to deter any successful intruders.
- Alarm systems which feedback to a 24h operators' desk which indicate the security status of each site, including cameras where available. This allows for a prompt security response.
- Prompt, security response leads to possible arrests and conviction of criminals.
- These measures develop and reinforce the local communities' understanding that the site is secure and monitored.

NMBM has started implementing:

- Smart intrusion detection telemetry alarms which monitor vibrations and light to intelligently differentiate between general knocks (such as livestock) and deliberate strikes for intrusion.

FIGURE 17: *Polymer concrete lid after vandalism*

FIGURE 18: *Smart, sheet moulding compound lid*

- Other telemetry includes temperature, humidity and water level alarms which allow for the detection of minor leaks and major leaks without time delay from the event.
- All alarms can be integrated into an online web-based application, and into the telemetry which is monitored 24/7.
- The application allows for live online monitoring to verify the secureness of the infrastructure.
- Private armed response contracts have backed up the internal municipal security. At implementation there were numerous intrusions attempts and later, there have been no recent attempts.

In the case study, The Motherwell reservoir site has got electric fencing, an alarm, and a private security contract covering the site. At implementation it was found that intruders would throw items onto the electric fence and after a while the regularity of recurrence decreased.

f. Access control:

A web-based access control system provides total lockout authority filtered down from management to Inspector. Strict access control as the smart keys are assigned to various authorized personnel. The access on these user keys is controlled and provides lockout authority filtered down to ensure that only authorized personnel can access a site. Data logging allows the division to easily audit activity on the site.

g. Community engagement:

Most people may accept that the infrastructure is there to serve a purpose and should be undisturbed. It is the criminal minority who transgresses these crimes upon utility infrastructure. It is important to educate people that the infrastructure is there to serve them and other

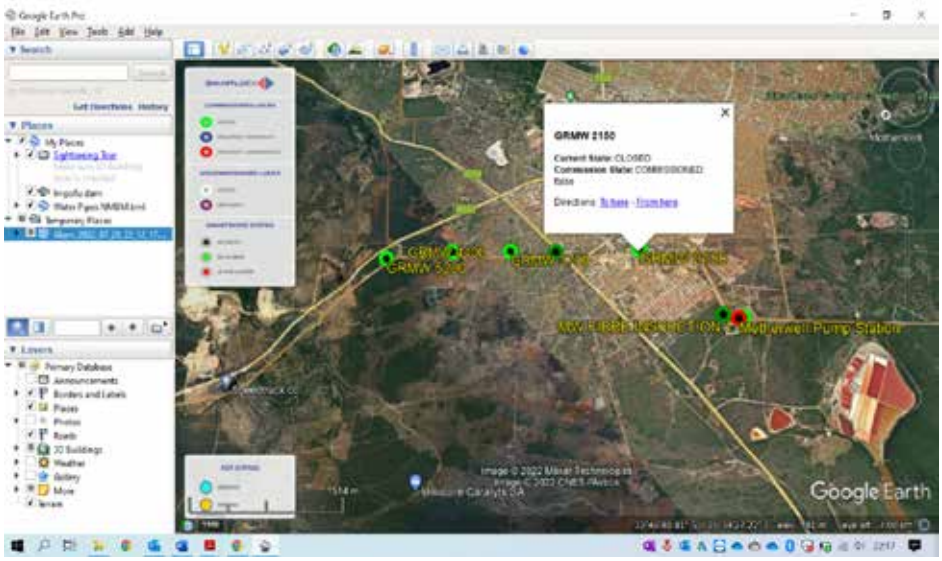

FIGURE 19: *Google earth snapshot of the live monitoring*

FIGURE 20: *Snapshot of the data logs for specified period*

citizens. Encourage the community to report vandalism by phoning the call centre if they witness it. To prevent the non-reporting of events one must ensure that their identity remains anonymous and ensure that the would-be reporter is aware of such an arrangement.

6. CONCLUSION

Year-on-year increases in crime present a negative outlook for upcoming years, coupled with the socio-economic development challenges, dictate that immediate action be taken. Completing a holistic approach could be the most effective method in combatting vandalism and other crimes transgressed upon utility infrastructure. There are several key points within the circumference of the fight against vandalism.

Implementing various preventative measures and learning from the failed attempts could be a good way to protect infrastructure. The asset must be structurally secured, it must have on-site deterrents and alarm systems and prompt security response. Support the various measures by planning the reaction-plan possible and ensure that there is an action plan for when an act of vandalism is committed. This will ensure that response teams can go directly to the area of concern shortening the response time and thereby increasing the chances of arresting criminal elements of the community. Security teams need to have a zero-tolerance approach with respect to the law and National Government and its relevant departments must strive for economic development and maintain order. The community needs to be engaged on the ground level to develop ownership of utilities which provide them with services with the goal of encouraging the reporting of suspicious activity and criminal activities.

7. RECOMMENDATIONS

This paper recommends to Municipal Engineers to take ownership of the infrastructure for which you are the custodian. Constantly engineer new or revised solutions but consider the softer, community engagement aspects. Problems in engineering must be thought through holistically and broadly to be effective. Actionable directions have been given with respect to both possible engineering solutions and community engagement.

In conclusion, proactively implement informed anti-vandalism measures by constantly adapting to "our changing world."

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